MV electrical network management

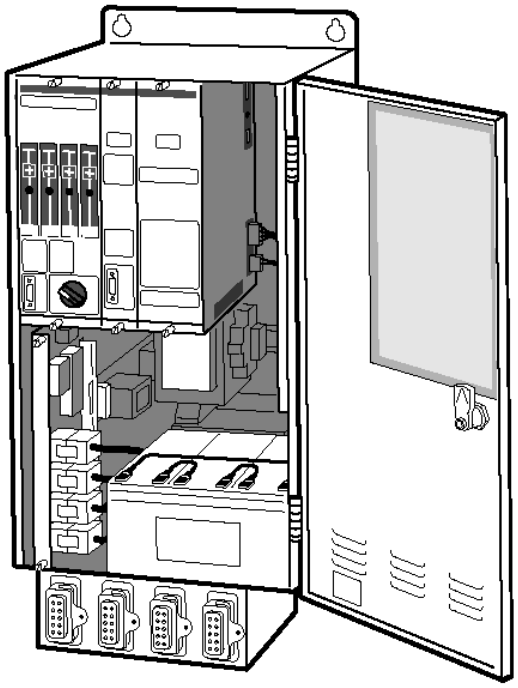
Easergy range

T200 & Flair 200C & R200-ATS100

MV substation control and monitoring units

DNP3 communication

Appendix to the User Manual



Schneider Electric

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1. Introduction

This appendix to the User Manual is designed to provide aid with setting up a telecontrol network using the DNP3 protocol. It will therefore provide information to help choose an operating mode, to make the corresponding configuration settings and to analyse any problems faced.

For this purpose, the following will be found:

- References of documents relating to this protocol
- Operating principles, with
  - a brief description of the specification and fundamentals of the protocol;
  - a description of the various operating modes with help in choosing between them;
  - a list of the types of data exchanged;
  - a description of the main functionalities;
  - a description of the DNP3 IP protocol.
- The configuration settings to be made, with
  - general configuration of the protocol;
  - specific configurations relating to the transmission media;
  - specific configurations relating to the objects exchanged;
- Maintenance aid facilities
- A glossary of specific terms (expressions written in italics in the text)
- The descriptive documents specified in the protocol specifications
- Object addressing tables which can serve as a model for establishing databases for the T200 and Flair 200C.

All along the documentation, the T200 is taken as an example. The software features of the T200 and Flair 200C are the same. As a result, the same information can be used indifferently with the T200 or with the Flair 200C.

2. References

As mentioned above, the purpose of this appendix is to help the user set up a network. It is not intended to provide a detailed explanation of the protocol specified in the documents referenced below. It is not necessary to read these documents. However, the user faced with a specific problem or wanting to have a more precise knowledge of this protocol will find it useful to read them. They are available, following registration in the DNP Users Group, on the website of that organization (www.dnp.org).

The 4 basic documents (also called "Basic 4 Documents") which define the DNP3 are called "Data Link Layer Protocol Description", "Transport Functions", "Application Layer Protocol Description" and "Data Object Library ". The Users Group also makes available to its members the document "DNP3 Subset Definitions" which allows integrators of the telecontrol network to:

- check that the equipments are capable of providing the desired information
- make sure that they are capable of communicating with one another.

Their references are as follows:

- Basic 4 Application Layer (26 June 1997)
- Basic 4 Data Link (26 June 1997)
- Basic 4 Data Object Library (10 July 1997)
- Basic 4 Transport Function (26 June 1997)
- Subset Definitions (20 December 1997)

Other documents can be consulted or used:

- IEC 60870-5-1 (1990) Telecontrol equipment and systems – Part 5: Transmission protocols – Section 1: Transmission frame formats
- IEC 60870-5-3 (1992) Telecontrol equipment and systems – Part 5: Transmission protocols – Section 3: General structure of application data IEC 60870-5-3 (1992)
- IEC 60870-5-4 (1993) Telecontrol equipment and systems – Part 5: Transmission protocols – Section 4: Definition and coding of application information elements

- Errata (15 December 1999)
- DNP Primer Rev A (21 March 2005)
- LAN WAN version 1 (8 February 1999)

- DNP3Spec-V1-Introduction-20070203 (3 February 2007)
- DNP3Spec-V2-ApplicationLayer-20070203 (3 February 2007)
- DNP3Spec-V2-Sup1-SecureAuthentication-20070203 (3 February 2007)
- DNP3Spec-V3-TransportFunction-20070203 (3 February 2007)
- DNP3Spec-V4-DataLinkLayer-20070203 (3 February 2007)
- DNP3Spec-V5-LayerIndependent-20070203 (3 February 2007)
- DNP3Spec-V6-Part1-ObjectLibraryBasics-20070203 (3 February 2007)
- DNP3Spec-V6-Part2-Objects-20070203 (3 February 2007)
- DNP3Spec-V6-Part3-ParsingCodes-20070224 (24 February 2007)
- DNP3Spec-V7-IPNetworking-20070203 (3 February 2007)
- DNP3Spec-V8-Interoperability-20070220 (20 February 2007)
- DNP3Spec-V8-Apdx1-DeviceProfile-20070220 (20 February 2007)

- TC-2006-12-20 - Main topics were security proposal and removal of PCB from subset 3 (4 January 2007)
- TB2007-001 UTC Requirement Notice (3 January 2007)

- Template for creation of device profile documents using MS Word (from V8-Apdx1 dated 20070220) (24 February 2007)
- MS Word Template for Application Notes DOT (6 February 2007)

- ZIP file containing XML schema, XSLT to convert XML to HTML document and sample XML instance files (20 February 2007)

3. Principles

3.1 General

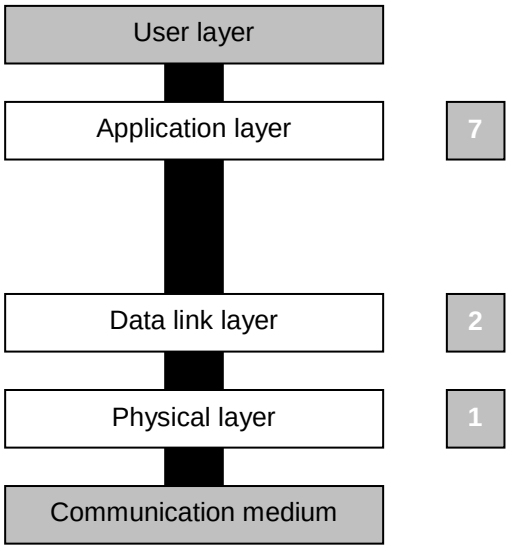
The development of DNP3 represented a major effort to allow interoperability - open and based on standards - between supervisors (except for inter-supervisor links), remote terminal units (RTUs) and intelligent electronic devices (IEDs) in the electric power area.
This has enabled the protocol to be also extensively used in water transport, the oil industry and the gas industry.

DNP3 is built on the basic standards resulting from the work of Technical Committee TC57 of the IEC, dealing with Power Systems and associated Communication Systems.

DNP3 has been adopted by the IEEE C.2 Task Force. It was developed by Harris, Distributed Automation Products. In November 1993, responsibility for the specification of future developments and ownership of the protocol were transferred to the DNP3 Users' Group. Thus, DNP3 is a public, open protocol.

3.2 ISO Model

DNP3 is based on the standards of the International Electrotechnical Commission (IEC), Technical Committee TC57, Working Group 03 which worked on a standard protocol for telecontrol applications based on a 3-layer ISO model *EPA – Enhanced Performance Architecture*, which is a simplified version of the 7-layer ISO model.



The three layers used are as follows:

- Physical layer;
- Data link layer;
- Application layer.

3.3 Transmission modes

The DNP3 protocol operates in master-slave mode if *Unsolicited Response* operation is not used or in master-master mode if this operation is used.

In the master-slave mode, the Supervisor is the master and the T200, as slave, merely responds to the master's requests.

In the T200, use of the *Unsolicited Response* function or not is determined by configuration (the conditions of this are detailed further on). Where it is used, the SCADA system can inhibit it or activate it remotely.

The information objects are broken down into several *classes*. *Class* 0 is used for static data (T200 states), *classes* 1, 2 and 3 for dynamic data (changes).

The operating procedure, without *Unsolicited Response* function, is generally as follows:

- When it starts up, the Supervisor initializes the link to the first T200.
- It sets the T200 time where necessary.
- It repatriates the T200 states (either by requesting *class* 0 objects, or by reading the various types of objects).
- It goes to the following T200.

Then, the Supervisor works by *polling*:

- It regularly repatriates all the T200 states (either by requesting *class* 0 objects, or by reading the various types of objects).

or

- It repatriates only changes of state and thereby maintains its database.

The Supervisor can send a command to the T200s at any time.

In this operating procedure, the SCADA system controls the communication load. Operation is simple, but results in intense use of communication media, because the more quickly one wants to be informed of a change, the more often the T200s must be interrogated. The polling cycle limit corresponds to the shortest cycle for interrogating all the T200s. This interchange is mostly "unproductive" because, in most cases, the T200 interrogated has nothing to report (on this subject, see, for example, in section 5.2 Tracing interchange with the Supervisor – Energizing the T200, the window in which appears a Request for class 1, 2 or 3 data (*polling*)).

The operating procedure, when the *Unsolicited Response* function is used, is generally as follows:

- When it starts up, the Supervisor initializes the link to the first T200.
- It sets the T200 time where necessary.
- It repatriates the T200 states (either by requesting *class* 0 objects, or by reading the various types of objects).
- It goes to the following T200.

When a T200 starts up:

- It initializes the link.
- It indicates to the SCADA system that it has just started by setting the *Device restart* bit in the corresponding octet of the *IIN - Internal Indications*.
- The Supervisor sets the T200 time where necessary.
- It then requests the T200 states (either by requesting *class* 0 objects, or by reading the various types of objects).

Then, messages are sent only to provide unknown information. For example, when a change occurs, the T200 will call the SCADA system via the *Unsolicited Response* function. This will make it possible to initiate dialogue and the SCADA system will then retrieve the change. Likewise, the Supervisor will send messages to the T200 when the operator requests order execution.

This operating mode does not heavily load the communication facilities (a device speaks only when it has something to say). On the other hand, the SCADA system no longer controls the data flow because it can be called at any time. Collisions between messages can occur when, at a given point in time, several devices take control to speak. We shall see further on how this problem of collisions is dealt with.

3.4 Data

The DNP3 protocol specifies the data that can be exchanged and the form in which they are transmitted. Among the numerous items of information to which the protocol gives access, there are:

- binary inputs (with or without additional indications);
- analogue inputs (in several formats);
- counters (in several formats);
- digital outputs;
- analogue outputs (in several formats).

These data, called *objects* in the DNP3 protocol, will be described in detail further on.

3.5 Functionalities

- Reading all the states of a T200
  This can be performed according to two methods by the SCADA. It can perform *Class 0 Data Reading* (method generally used) or perform a set of *Reading operations* concerning each type of *object* of the T200. The latter will send back, in reply, the state of all the static data (first methods) or the state of all the *objects* corresponding to the types requested (second methods) on condition that a transmission address has been defined for each of these *objects*.

- Time setting
  This can be performed by the Supervisor:
  - either individually, for each T200, with confirmation by the latter that it has received correctly;
  - or all at once, by *broadcast*, for all the T200s on a given transmission medium. In this case, the T200s in question do not reply.
  On those media that offer a repetitive transmission delay, the SCADA can correct the synchronization of the transmission time with the T200s, by first sending a transmission delay measurement (*Delay Measurement*).

- Transmission of changes, routine transmission
  The T200 can transmit changes on signals, measurement changes (upon a change exceeding the dead band, upon crossing a threshold), and regular measurement reports.
  These changes may be dated or not.

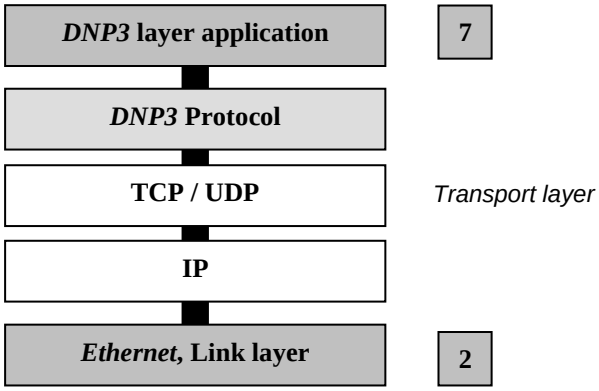
- Counter processing
  It is possible to freeze the counters.

- Commands
  Two command modes are available: *Select then Operate* and *Direct operate*.

- Modification of parameters
  It is possible to modify certain parameters.

3.6 DNP3 IP

DNP3 protocol was originally designed for serial point-to-point communication (e.g. RS-232) with limited support for half duplex serial networks (e.g. RS-485). In order for the T200 to exchange DNP3 messages in a local or wide area network, the dnp3 protocol is also implemented over Ethernet via TCP/IP protocols. We will call it DNP3 IP. Its implementation in the ISO model can be interpreted as followed:



- Transport layer and protocol characteristics:

As we can see above, the Transport layer of the internet protocol suite consists of two distinct services, User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). Both protocols are available on the T200 but their use varies according to the application:
- TCP shall be the primary transport service for DNP3 messages because of its reliably.
- UDP can be used on a high-reliability single-segment LAN and in specific cases where small pieces of non-critical data need to be sent or when broadcasting is required.

- Background TCP/UDP:

For a TCP connection to take place one side must be the server and one side must be the client. Client-Server architecture is therefore provided. The side of the link that initiates the connection is the client and the side of the link that waits for a connection request is the server. The client requests a connection by specifying the IP address and port number of the server. Once the connection is made, data is transferred without either side having to specify the IP address and port number.
The T200 is usually associated to the server and can hold two different TCP connections with a SCADA. Each connection with a client is managed by a disconnection delay if no data is exchanged. What's more, the '*Dual End Point'* mode allows the T200 to initiate a connection to a supervisor. In this case, a specific outgoing port can be set.

For UDP communications, each side includes the address and port number with each transmission. Each host that receives a UDP datagram is then provided with the sending host address and port number.
However, two distinct modes are available to answer a request. The first one consists of using the datagram port to send a reply, the second one of using a specific destination port.

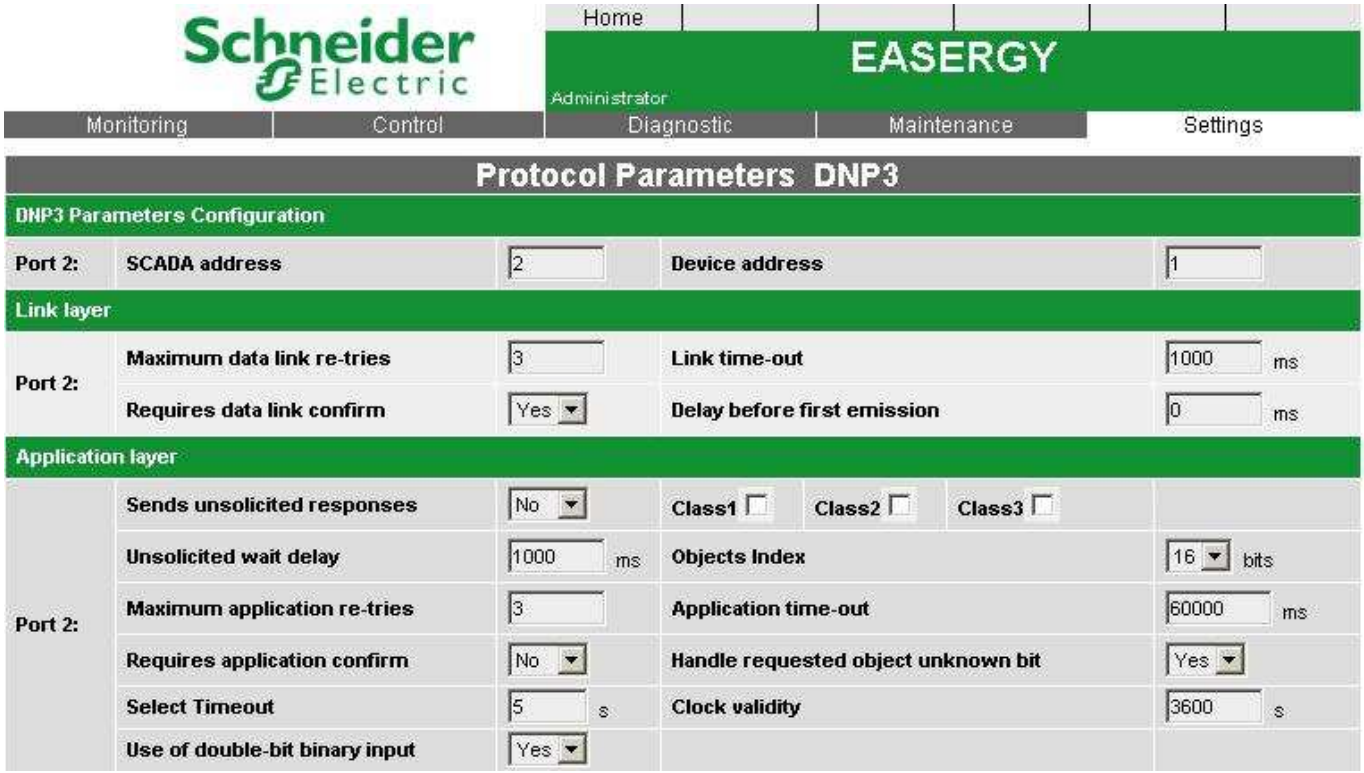
- Default ports used for DNP3 IP:

The T200 support TCP and UDP communications on port number 20000. All connection requests and all UDP data are sent to this common port number. Port numbers can be changed for particular reasons.

4. Configuration

4.1 General configuration of the protocol

A configuration screen contains all the parameters directly related to the Protocol.



Parameters Setup Page / Protocol

DNP3 parameters:

- SCADA address
  This identifies the SCADA system. On the network, it allows the T200 to designate (in Send mode, as *Destination Address*) or recognize (in Receive mode, as *Source Address*) the SCADA system.
  It can take any value between 0 and 65534.

- Device address
  This identifies the T200. On the network, it allows the T200 to designate itself (in Send mode, as *Source Address*) or recognize itself (in Receive mode, as *Destination Address*).
  It can take any value between 0 and 65534.
  Address 65535, non-configurable, is used by the Control Centre to address all the remote terminal units (*Global Request*). In that case, the T200, like the other remote terminal units, does not reply to the SCADA.

Link layer:

- Maximum data link re-tries
  When data transmission fails (disturbed frame), the link layer controls repetition of the frame. Here one sets the number of times that this frame will be repeated, without confirmation of a correct reply, before the link is declared as cut.
  Configurable from 1 to 10.
  The customary values are in the range between 2 and 4.

- Link time-out
  This is the time during which the T200 waits for acknowledgement of the frame sent by it. After this time, it will repeat the frame or declare the link invalid as mentioned above.
  The choice of a value depends on the speed of transmission. The higher the speed, the lower the value that will be inserted.
  In systems in which the frames sent by the T200 can come into collision with the frames sent by the Control Centre, it is important to insert a timeout value greater than that appearing at the SCADA end. For example, if the SCADA and the T200 send at the same time frames which come into collision (half-duplex type operation), repetition of these frames will be performed first at the SCADA end and then at the T200 end. If the values had been identical, they would have been executed simultaneously, thus creating a new collision.

- Requires data link confirm
  There are two ways of handling a sent frame. *The Send / No reply expected* service entails no confirmation by the equipment for which it is destined. This service corresponds to the choice "No".
  The *Send / Confirm expected* service requires confirmation by the destination. It corresponds to the choice "Yes".
  The *Send / No reply expected* service makes it possible to reduce the number of frames exchanged and hence accelerate the flow of information over a link. However, it should be avoided on noisy transmission media (messages are frequently disturbed and in this case the sender does not know that the frame has not been received correctly). It is therefore in practice usable only on dependable media. Such media are links such as RS-232 links, optical fibre links, etc. on which the speeds are generally very high. This explains why it is generally not used. However, it is possible to configure it.

- Delay before first emission
  To prevent several T200's calling at the same time to indicate a common event, it is possible to configure different waiting times for each of the T200's before they go into call mode. Calls to the SCADA system will then be deferred and will not interfere with one another.

Application layer:

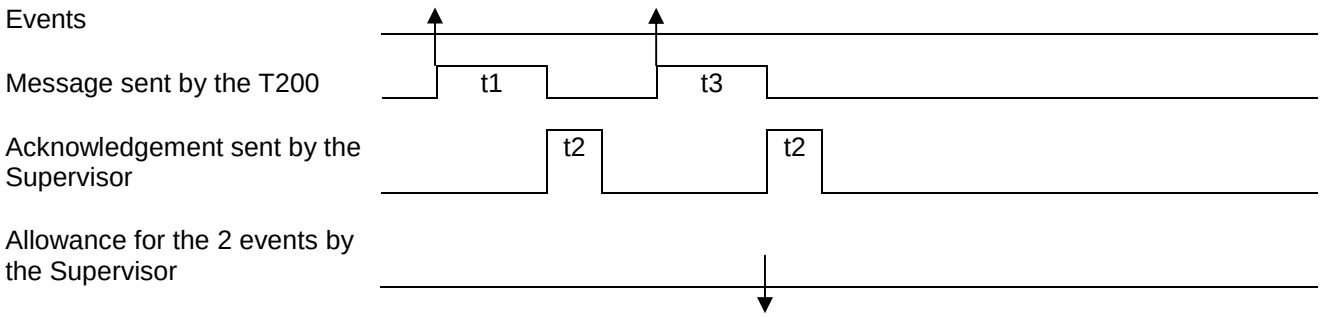
- Sends unsolicited responses
  It is here that the operating mode is chosen. When one chooses "Yes", the *Unsolicited Response* function is controlled.

- Class 1, class 2, class 3
  The *Unsolicited Response* function, when it is validated (see above), may be used only for certain *classes* of *objects*. This selection is made by checking the boxes of the *classes* for which one wants to use this operation. For example, one wants certain events, considered important for control, to generate spontaneous sending to the SCADA system, whereas others, useful for control but not essential, do not cause spontaneous sending by the T200. In that case the former will be placed in *class* 1, and the latter in *class* 2 or 3. *Sending of an Unsolicited Response* will be validated for *class* 1 by checking the corresponding box, but not for *classes* 2 and 3 by leaving their boxes deselected.

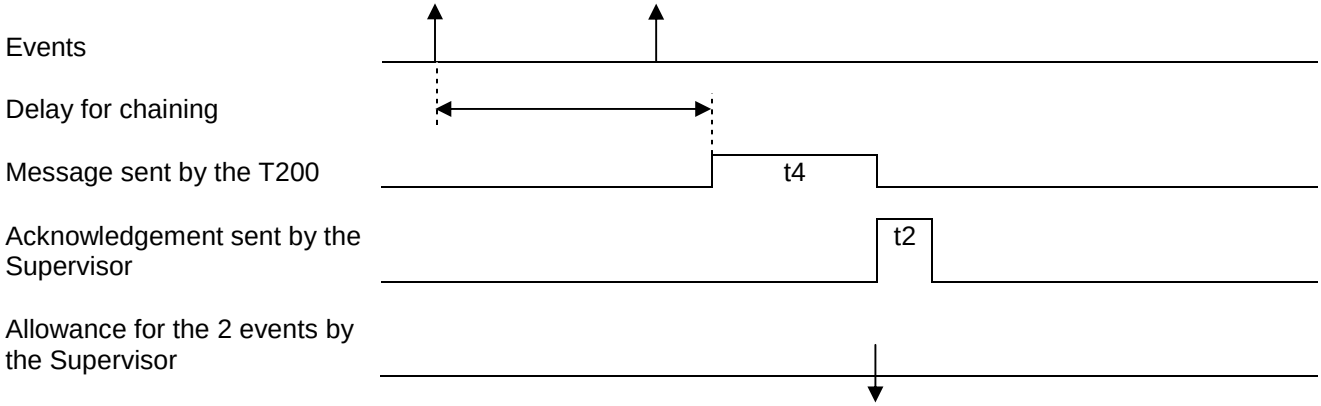
- Unsolicited wait delay
  So as to limit traffic - which can be advantageous when using multipoint media such as radio - it may be desirable to group several items of information in a single frame, rather than send this information at a rate of one information item per frame.
  By setting this delay for chaining, one ensures that, before sending a new information item upon a change, the configured delay is waited so that, if another change occurs during this delay, this change can be grouped together with that which one would have sent alone if this delay had not been set.

  The following diagrams show the various types of operation

  - No delay for chaining (zero delay)



  - Delay for chaining (zero delay)



  The network occupancy in the first case is equal to t1 + t3 + (2 x t2), and in the second case to t4 + t2. It is greater in the first case. On the other hand, the SCADA system is informed of the 2 events later in the second case.

  Comment: the second event does not reinitiate the delay for chaining.

- Objects index
  In the T200, the address (*Index*) of the *objects* can be coded on 8 or 16 bits (1 or 2 octets). In the former case that limits to 256 *objects* the number of *objects* of the same *Data Object* type that can be transmitted, while in the second case one can have up to 65536 *objects* of the same general *Data Object* type.
  It is always advisable to limit the size of messages exchanged, so one should choose, when possible, a size of 8 bits. Go to 16 bits when the number of objects of the same general *Data Object* type is greater than 256.

- Maximum application re-tries
  A system similar to that for checking correct reception of a message at the link level can be implemented at the application level. Here one configures the number of times that an application information item will be repeated in the case of non-confirmation of reception.
  Configurable from 1 to 10.
  The customary values are in the range between 2 and 4.

- Application time-out
  This is the delay during which the T200 waits for confirmation of correct reception of the application information item sent.
  The choice of value must take into account any repetitions at the link level. It must therefore be greater than the delay between first sending of the frame containing the information and the end of waiting for the last repetition of this frame at the link level.

- Requires application confirm
  Setup of the system for checking correct reception of application information is performed or not in this section.

- Handle requested object unknown bit
  When a telecontrol network is operational, the Supervisor normally requests of the remote terminal units only objects managed by the latter. However, during the stages of configuration of this network, it can occur that the SCADA system requests of a remote terminal unit objects that are non-existent in it. To facilitate understanding of the non-return of these objects, the T200 marks a bit in the octet in question with *IIN - Internal Indications*. This bit is called *Requested object(s) unknown*.
  However, this bit is not managed by some SCADA systems, and worse, for some of them its presence causes malfunctioning of the Supervisor. To prevent this problem, one can configure, here, inhibition of marking of this bit by the T200 when necessary.

- Select timeout
  This is the maximum time authorized between receiving a command selection and receiving its execution. After that time, the command is rejected.
  This time is applicable only in the *Select then Operate* mode. It can be set to between 1 and 60 s.

- Clock validity
  Like any clock, the T200's clock deviates over time. Depending on the deviation he considers acceptable, the user will configure the time after which he determines that the deviation is too great to consider the time tag valid.
  The T200 declares the clock invalid after power up or when the set time has elapsed since the last *clock synchronization command* received.
  This time can be as much as 24 h. By setting 0, the T200 considers the time as infinite, i.e. the clock will not be declared invalid.
  The clock deviation is 5 ppm at 25°C, i.e. about 40 0 ms per day (less than 15 s per month). If the user wants a deviation of less than 100 ms, he will have to set the time on the T200 approximately every 6 h. He need then merely program 22,000 ms (leaving a little margin) for the clock to be declared invalid if the T200 has not received a time setting within a period of slightly more than 6 h (6 h 6 min. 40 s).

  Special case of the GPS option: In this case, time setting of the T200 is performed from the GPS. The clock will be declared invalid only after power up or after expiry of the time without the GPS providing valid time setting data. The user will then be notified, when he receives a time tagged event, that the GPS is not working correctly.

When the operating mode with *Unsolicited Response* is selected (and saved) , an additional window opens in the Protocol Parameters screen.

This window is related to the problem of collisions that can occur when the T200 calls to transmit an *Unsolicited Response* (see 3.3 Transmission modes). It depends on the transmission medium used.

For point-to-point systems (telephone, GSM), the window is that which conventionally appears when these types of media are used. It is therefore described in the T200 User Manual in the chapter corresponding to such media.

For multipoint systems (radio, radio type leased line, etc.), the following window appears:

Collision avoidance

Collisions may occur:
- between frames sent by the SCADA and frames sent by a remote terminal unit;
- between frames sent by various remote terminal units.

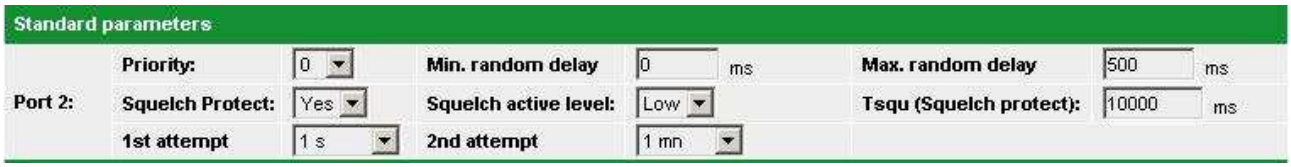
It is often easy to limit their consequences in the former case. A different link timeout - see above - will be set at the SCADA end and at the remote terminal unit end. In this way, if 2 frames collide, their repetitions will be deferred and the problem will be solved.

The second case is more complex. To avoid collisions insofar as possible, one must know the network occupancy state. The more reliable this information, the more efficient the system. It is true that one can forcibly adopt sending only if the network is free.
However, this has its limits, since two devices may see the network free and start sending simultaneously.
Even apart from this case, there is always a time lag for detection of network occupancy. Let us consider a device going into sending mode. Throughout the time needed for detection of this state, another device will consider the network as free and will therefore be authorized to send.
To overcome this, it is possible to use collision avoidance.
Depending on the transmission medium, there will be several possible options:
- Non-activated or Standard
- Non-activated, Standard (squelch used for busy state), Standard (DCD used for busy state).

The first group of options is proposed when the transmission medium can provide the occupancy state via the DCD signal. This is the case when the sent frames are delimited by a signal (generally RTS), said signal being linked to the DCD or causing its activation (case in which the RTS signal causes rising of a carrier detected on DCD by the other device).

The second group of options is proposed when using a radio medium. There are generally 2 signals: the DCD signal (carrier detection) and the squelch signal. When the squelch signal is available, it should be preferred to the DCD signal. This is because carrier detection can be caused by noise on the line, whereas the squelch is generally more "secure" and gives more reliable information.

In the second option, when collision avoidance is activated, an additional window appears in the Protocol Parameters screen.



Before describing the various parameters used, we shall explain how collision avoidance operates.

We shall consider two types of frame:
- acknowledgement frames;
- other frames.

When a T200 receives a frame from the Supervisor and this must be acknowledged by it, the acknowledgement frame is sent immediately.
For the other frames, the T200 will allow for a waiting time before sending:
This time is calculated by the following formula:

time = (priority x min. random time) + random time
The random time ranges between the min. random time and the max. random time.

- Priority
  This parameter can be used to hierarchize various T200s.
  The smaller the number, the more priority is assigned to the T200 (it will wait for a shorter time).
  Usually, this priority is left at 0.

- Min. random delay
  Max. random delay
  The random timeout, added to the wait related to the priority, is in a range between the minimum and maximum values defined here.
  There are no typical values for these parameters. Setting should be performed taking into account the following comments:
  - The timeouts are to be set according to the sending time for a frame.
  - The smaller the minimum timeout, the smaller the added timeout can be.
  - The greater the difference between the minimum timeout and the maximum timeout, the smaller the risk of sending by two T200s at the same time.
  - The preceding condition is achieved by increasing the maximum timeout. But allowance should be made for the fact that the greater this timeout, the longer the T200 risks waiting before sending. Generally, therefore, one opts for a value that will not be too high.
  The ideal solution, therefore, is to choose parameters in accordance with the above rules, and then refine them in the field.

The other parameters concern the signal used to obtain the network occupancy state.

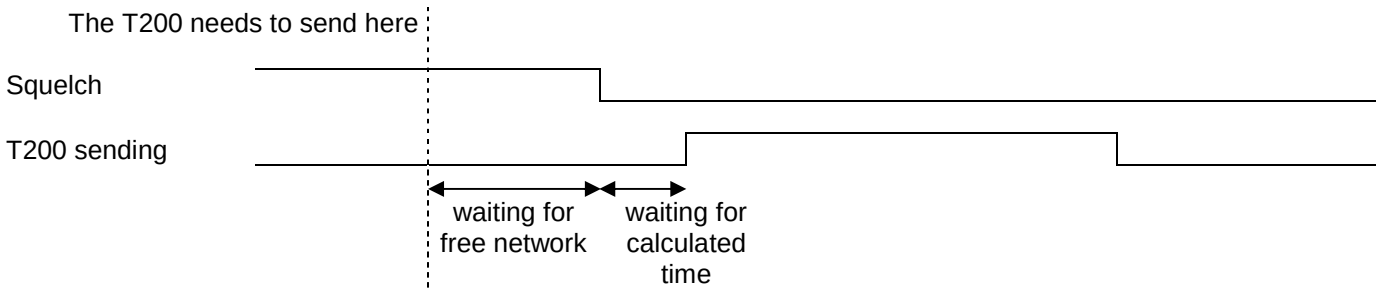
- Squelch active level
  Depending on the equipment, the squelch active state will be a low level or a high level. One should therefore choose, here, the appropriate level.

- Squelch protect
  The squelch is an occupancy signal provided by analogue type radio equipment. With this transmission medium, the transmission conditions vary with time. For example, the transmission conditions are altered depending on whether or not there are leaves on the trees. Therefore, reception levels generally vary throughout the year. Accordingly, the squelch is related to the value to which its detection level has been set. This setting is normally performed in the field and in periods when reception is least satisfactory. However, despite all the precautions taken, squelch detection may become active permanently or over long periods of time. This means that, in this case, the T200 is therefore no longer authorized to send. To avoid this, squelch protection can be activated.
  When it is activated, this protection system will ensure that, when the squelch is active at the time when the T200 wants to send and when it remains active permanently during the time defined below, sending by the T200 will be authorized after this time.

- Tsqu (squelch protect)
  This time is the time referred to above.
  The customary value is approximately 10 s.

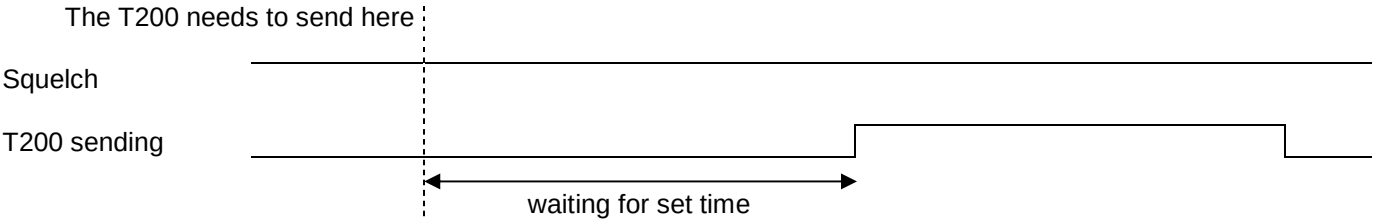
Explanatory diagrams

Normal case

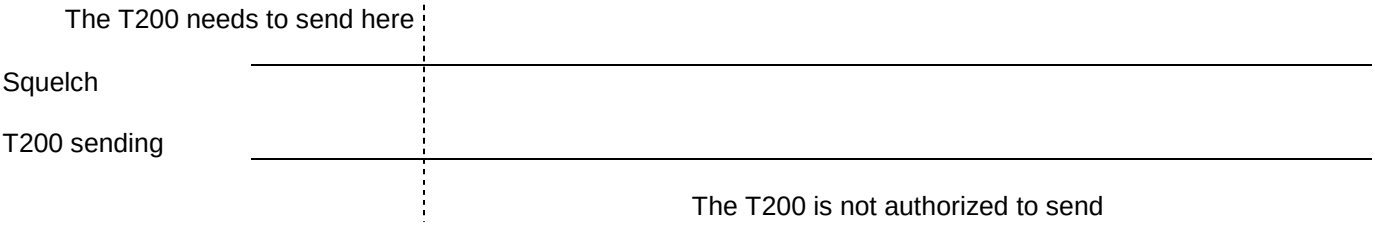


Case of permanent squelch

- with squelch protection



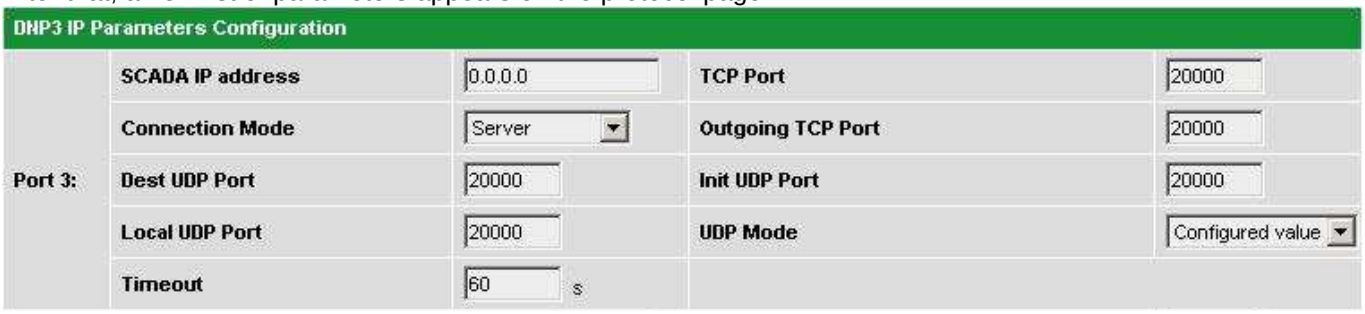
- without squelch protection



4.2 DNP 3 IP configuration

We saw on chapter 3.6 that DNP3 protocol can also be used over Ethernet. Consequently, there are some new parameters related to the TCP/IP layer that must be set.
Beforehand, the DNP3 IP must be activated. (*Operating mode* menu)

After that, a new list of parameters appears on the protocol page:



- SCADA IP address
  Specifies which supervisors can initiate a connection with the equipment. (IP filtering).
  0.0.0.0: All SCADA addresses are allowed. (No filtering)
  255.255.255.255: No SCADA address allowed. (Global filtering)
  xxx.yyy.www.zzz: Single SCADA IP address allowed.

- TCP Port
  Server TCP port number (Listen).
  Application: It is used when the T200 is waiting for a connection request.

- Connection Mode
  - TCP server only.
  - UDP only.
  - Dual end Point. (Used if the T200 must be able to initiate the connection to a supervisor)

- Outgoing TCP Port
  It can be only used in '*Dual end Point*' mode when the T200 initiates the connection.

- Dest UDP Port
  UDP port used for emission.
  It is only used if UDP mode is '*configured value*'.
  Consequently, The T200 will use this field to answer a request.

- Init UDP Port
  Port used for first unsolicited message if no UDP datagram has yet been received.

- Local UDP Port
  Listen UDP Port

- UDP Mode
  Configured value: The T200 sends a reply by using the '*dest UDP''* port.
  Source value: The T200 sends a reply by using the datagram port. (contained in the request)
  No UDP: The UDP protocol is not used.

- Timeout
  « Keep-alive » link fault detection delay.
  It is used in TCP to end a session with a client if no data is exchanged.

4.3 Specific configurations related to transmission media

The DNP3 protocol defines the format of transmitted frames. This format is FT3, itself defined in IEC Standard 60870-5-1.

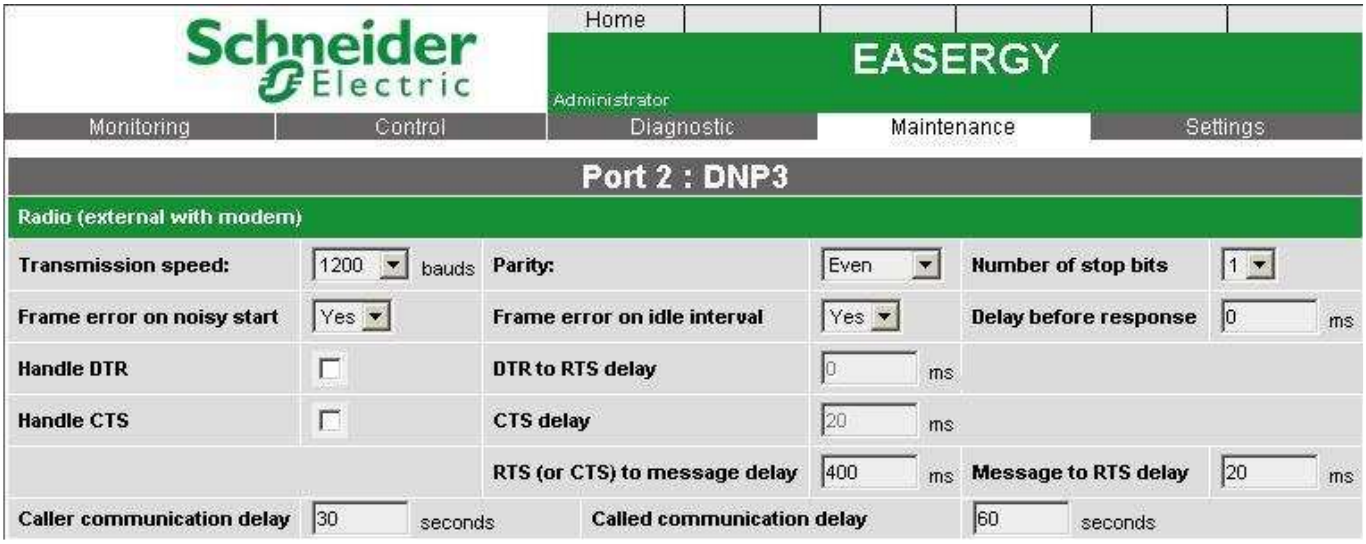
Here, in summarized form, are the main specifications of these frames:
- Each frame begins with a start character coded on 2 octets.
- The frames are formed of blocks containing at most 16 user data octets, supplemented by a check sequence coded on 16 bits.
- There are fixed-length frames and variable-length frames. The length of each frame is checked relative to the fixed length (fixed-length frame) or the transmitted length (variable-length frame).

These specifications make it possible to work in asynchronous or synchronous serial transmission. In the case of the T200, only asynchronous transmission is managed. This does not prevent operation between modems in synchronous mode once the modem has restored the frames in asynchronous form to the T200.

In asynchronous mode, transmission usually takes place by means of characters with 1 start bit, 8 data bits, no parity bit and 1 stop bit.

However, other characteristics may be required by the modems used for transmission.

Via the parameters proposed in the window relating to the transmission port in question, one can change some of the characteristics to be compatible with the modem used.



Parameters Setup Page / Port 1: transmission

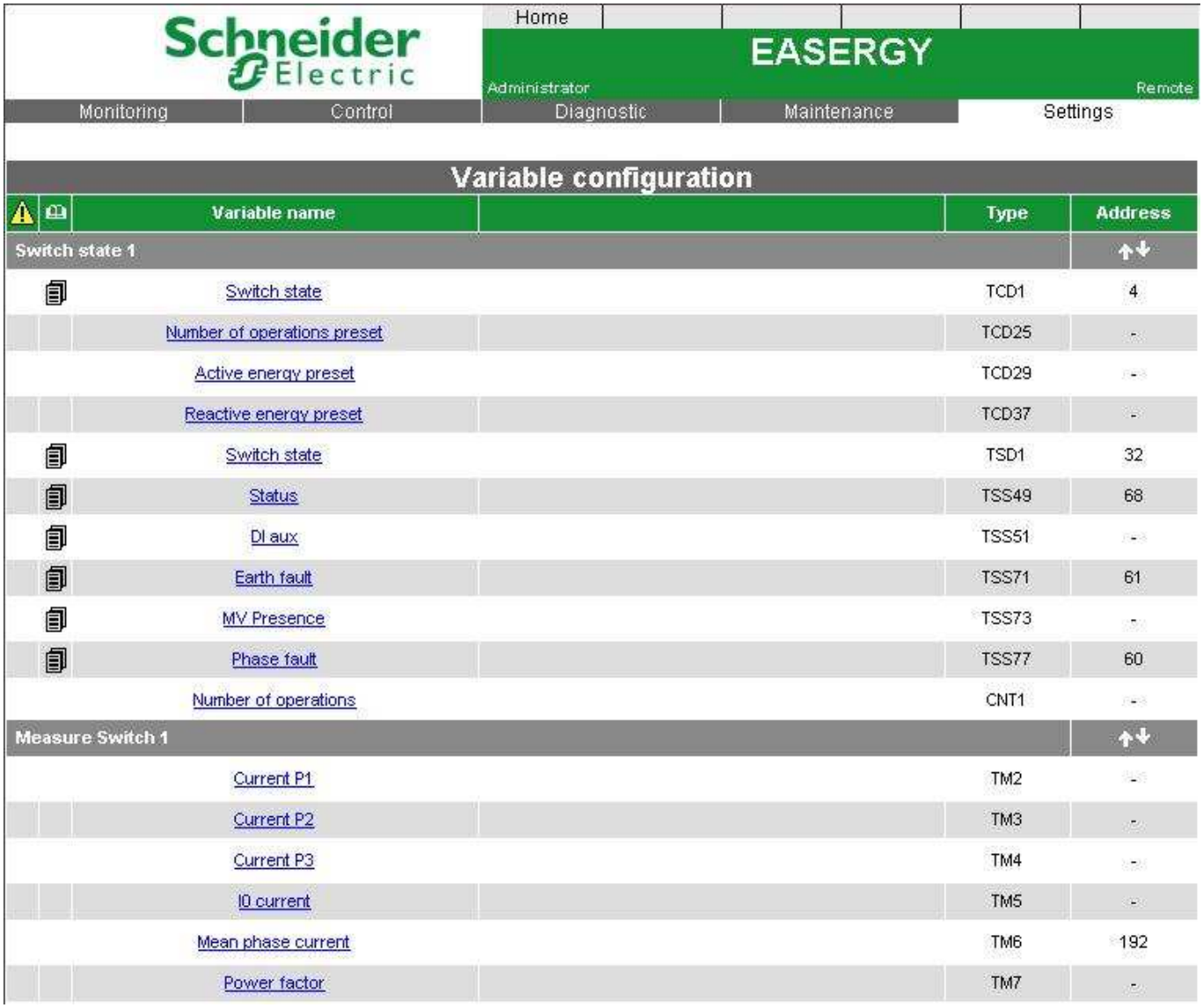
- Parity
  It is possible to configure the following parity cases: even, odd, space, no parity.
  Comments:
  - The fact of configuring a parity results in a longer message transmission time. In some cases, however, the message transmission time is insignificant by comparison with the delays before and after the message. The impact will in that case be weak.
  - The message transmission security due to use of the FT3 format is adequate and does not require use of a parity for character transmission.

- Number of stop bits
  Two stop bits can be configured instead of one bit.

- Frame error on idle interval
  The T200, being able to operate in IEC 60870-5-101 protocol, is capable of detecting a gap greater than 1 bit between 2 characters of a frame.
  If this detection is configured as causing rejection of the frames having this feature, transmission security is increased, but this is not necessary (the security ensured by the FT3 format being adequate).
  This also makes it possible to return sooner to resynchronization waiting.
  But this configuration implies that the Supervisor and the modems involved in the transmission circuit ensure that there are no gaps. While this is sometimes true with regard to the Supervisor, it is not true for many modems (case of packet transmission between modems).
  There is therefore no advantage in setting "Yes" for this parameter, but the possibility of doing so is left to the user.

4.4 Specific configurations of the objects transmitted

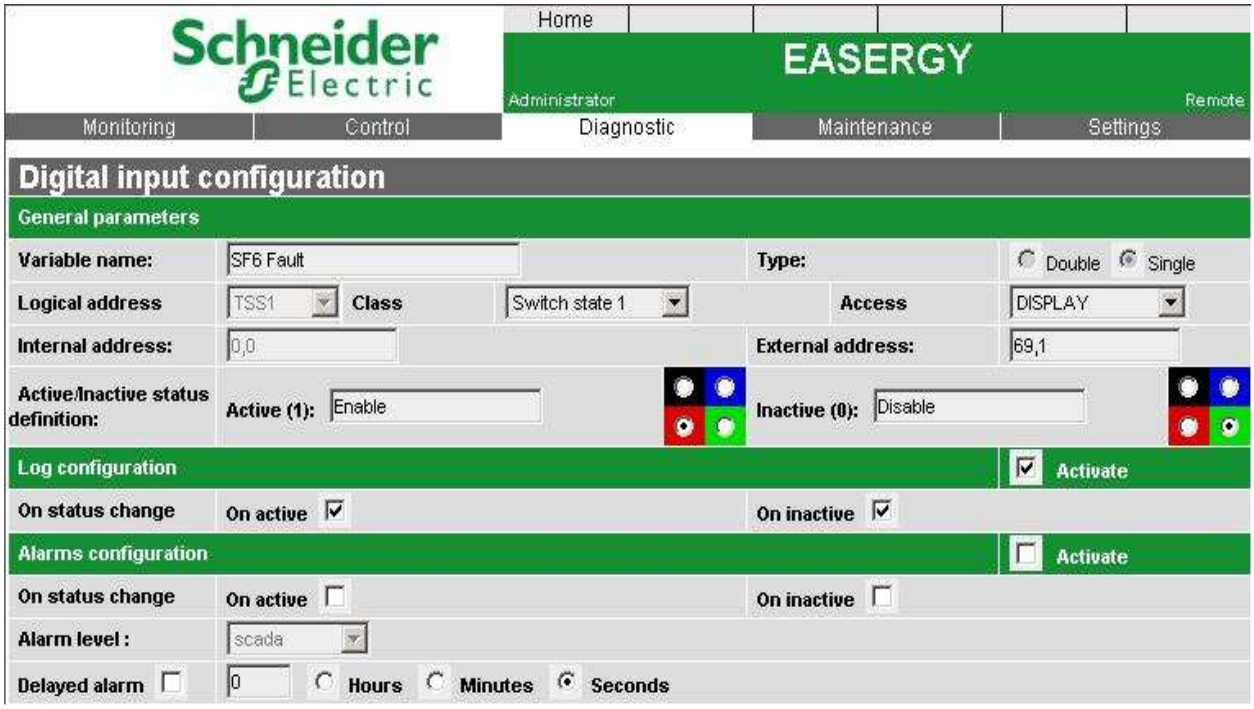
As mentioned above, dynamic *objects* (the result of changes) can be divided into 3 *classes* (*class* 1, *class* 2 and *class* 3). At any given time, the Supervisor may request only the objects specific to a particular *class*.
To assign an *object* to a *class*, you must go to the variable configuration screen.



Parameters Setup Page / Variable Configuration

You must then open the window relating to the variable (*object*) selected.

We have selected, below, the Default SF6 variable.



Parameters Setup Page / Variable Configuration / Default SF6

The external address (*Index*) has been configured in the form 69,1 - where 69 represents the *index* and 1 the *class*. After saving, the following screen appears:

Switch state 1			
	Switch state	TCD1	4
	Preset number of operations	TCD25	-
	Switch state	TSD1	32,1
	load break switch	TSS49	68,1
	SF6 fault	TSS51	69,1
	I0 fault	TSS71	61,1
	Voltage absence	TSS73	-
	Imax fault	TSS77	60,1
	Number of operations	CNT1	70,3
Measurements 1			
	Preset active energy	TCD29	-
	Preset reactive energy	TCD37	-
	Current P1	TM2	-
	Current P2	TM3	-
	Current P3	TM4	-
	I0 current	TM5	-
	Mean phase current	TM6	192,2
	Power factor	TM7	-

Parameters Setup Page / Variable Configuration

In this example, note that, for the information one wants to transmit to the SCADA system (information for which an address (*Index*) has been configured, 3 *classes* have been used: *class* 1 for important signals (necessary for operation), *class* 2 for measurements (operating help) and *class* 3 for the operation counter (maintenance).

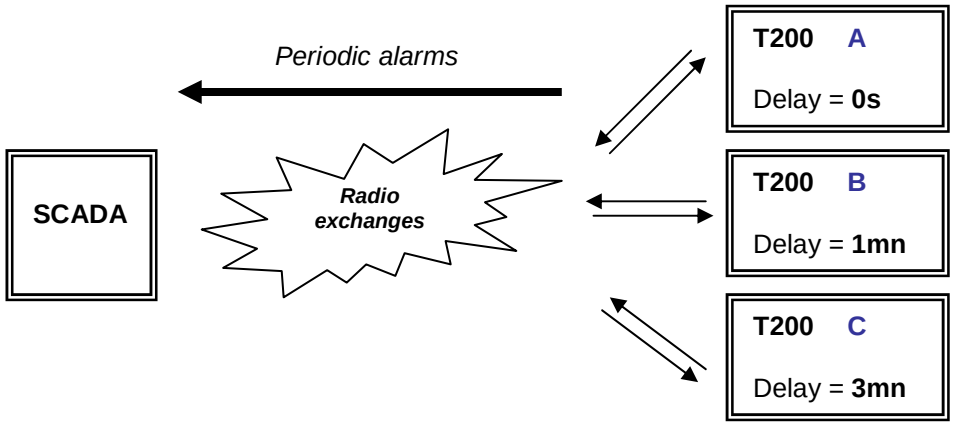
Comments:
- If only one *index* is specified, the *class* assigned will be *class* 1 by default.
- Many users use only *class* 1. In that case, the Supervisor repatriates all the change information in a single time operation.

• Measurements Time lag for radio communications:

- *Background*:
We suppose that several T200 can send periodically and spontaneously their measurements to a SCADA (*Balanced* mode). Therefore, collisions can occurred and the SCADA won't be able to receive all T200 changes of state.

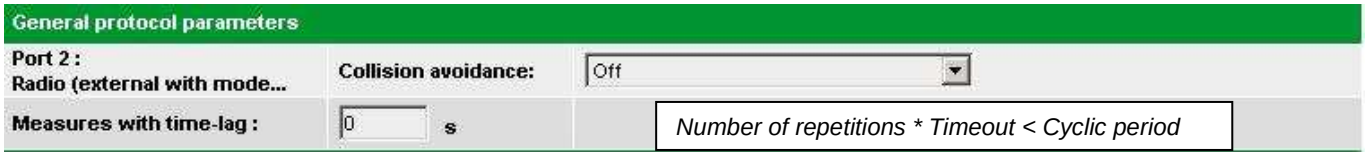
- *Solution*:
We provide a new parameter for each T200 which delays the sending of periodic measurements.

- *Example*:
We have three equipments that send their measurements every 15 minutes. We introduce a delay of 1mn for *T200 B* and a delay of 3mn for *T200 C*.



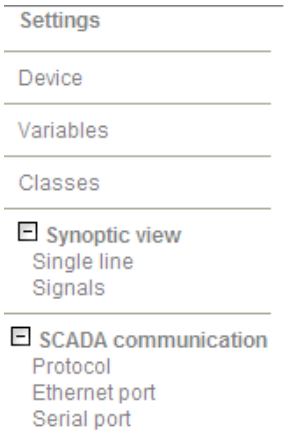
=> If the next sending is scheduled at 3:15 pm, T200 A will send its alarm at 3:15 pm whereas T200 B will send it at 3:16 pm and T200 C will send it at 3:18 pm.

- *Settings*:
The new parameter appears on the *protocol* page only if a radio modem has been selected and if '*unsolicited responses'* are allowed.



- *Remark*:
Make sure that all settings have been defined properly. (Time-lag, cyclic period, number of repetitions in case of failure, Timeout, caller communication delay…). Time-lag should be defined last.

4.5 R200-ATS100, configuration of the protocol



The protocol configuration can be found under Settings \ SCADA communication \ Protocol.

Most parameters are similar to T200/F200C, and described in chapter 4.1.

Protocol Parameters - DNP3

DNP3 Parameters Configuration				
Port 1	Scada address	2	Device address	1
Port 3	Scada address	2	Device address	1
Port 4	Scada address	2	Device address	1
Link layer				
Port 1	Maximum data link re-tries	3	Link time-out (x1ms)	1000
	Requires data link confirm	Yes	Delay before first emission (x1ms)	0
Port 3	Maximum data link re-tries	3	Link time-out (x1ms)	1000
	Requires data link confirm	Yes	Delay before first emission (x1ms)	0
Port 4	Maximum data link re-tries	3	Link time-out (x1ms)	1000
	Requires data link confirm	Yes	Delay before first emission (x1ms)	0

Application layer				
Port 1	Sends unsolicited responses	No	Class1 Available	Yes
			Class2 Available	No
			Class3 Available	No
	Unsolicited wait delay (x1ms)	1000	Objects Index(bits)	16
	Maximum application re-tries	3	Application time-out (x1ms)	60000
	Requires application confirm	No	Handle requested object unknown bit	Yes
	Select Timeout (x1s)	5	Clock validity (x1s)	3600
	Use of double-bit binary input	Yes	TM read mode	Standard

There are some slight differences:

- TM Read Mode:
  Measurements scaling mode: Standard, Adjusted or Normalized.
  Adjusted and Normalized are IEC60870 related scaling processes. They are available for compatibility reason, but should not be used. Refer to NT00156 for details.

- DNP3 IP TCP configuration:
  The parameters for DNP3 IP can be modified under Settings \ SCADA communication \ Ethernet Port

DNP3 IP Parameters Configuration

Communication parameters on TCP/IP ports				
Protocol	DNP3 TCP/IP	Link	Off	
DNP3 IP Parameters Configuration				
Port 3	SCADA IP address	0.0.0.0	TCP Port	20000
	Connection Mode	Server	Outgoing TCP Port	20000
	Dest UDP Port	20000	Init UDP Port	20000
	Local UDP Port	20000	UDP Mode	Source Value
	Timeout (x1ms)	60000		
Port 4	SCADA IP address	0.0.0.0	TCP Port	20000
	Connection Mode	Server	Outgoing TCP Port	20000
	Dest UDP Port	20000	Init UDP Port	20000
	Local UDP Port	20000	UDP Mode	Source Value
	Timeout (x1ms)	60000		

Save Cancel

Refer to chapter 4.2 for these parameters' description.

- DNP3 Class assignment:
  Each variable can be assigned to DNP class 1, 2 or 3.
  It is not done using the "External address" field, but a separate field, "DNP Class".

Variable Configuration

General				
SPS_30	Name	AC OFF	Access	Display
	Class	Cubicle 1	Rank	
	Source	Modbus	External address	8025
Single point status (SPS)				
DISPLAY	Active (1)	Yes	Inactive (0)	No
Triggers	On active	Log Event Alarm	On inactive	Log Event Alarm
Alarm	Alarm level	scada + sms		
	Delayed alarm	Yes No	10	Hours Minutes Seconds
DNP3	DNP Class	1 (1 / 2 / 3)		
Modbus				

5. Diagnostic

This chapter provides information which may be necessary when operating problems are encountered. They may help with problem resolution in such cases.

5.1 Processing protocol-related information

This section provides information on the way in which the T200 handles certain specific aspects relating to the DNP3 protocol.

- Representation of double signals
  In DNP3, there are only *Binary Inputs* to transmit a signal. The *state* of a *Binary Input* is given on a state bit (*State)*. These binary inputs can be accompanied by additional information grouped together in a *Status*.
  For double signals, the T200 uses the *State* bit of the binary input to represent the closed position of the double signal and the *On-line* bit in 0 state to indicate a complementarity fault.
  The following table gives a summary of representations of a double signal

Switch position:	*Status*							
	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
	State							*On-line*
Complementarity fault (2 inputs at 0)	0	-	-	-	-	-	-	0
Open	0	-	-	-	-	-	-	1
Closed	1	-	-	-	-	-	-	1
Complementarity fault (2 inputs at 1)	1	-	-	-	-	-	-	1

The bits found in the two octets of *IIN - Internal Indications* are processed as follows:

- All stations message received - octet 1 - bit 0
  Marked after receiving a message addressed to all the remote terminal units (destination address: 65535), reset after the following response of the T200.

- Class 1 data available - octet 1 - bit 1
  Class 2 data available - octet 1 - bit 2
  Class 3 data available - octet 1 - bit 3
  When the T200 has data to be transmitted in a class, the corresponding bit is marked. It disappears when there are no longer any data in the corresponding class to be transmitted.

- Time-synchronisation required from the master - octet 1 - bit 4
  This bit is marked at start-up of the T200 and when the clock validity time has expired since the last time synchronization received by the T200 (see above 4-1 General configuration of the protocol - Clock validity). It is reset when the T200 receives a time setting sent by the SCADA system.

- Station in local mode - octet 1 - bit 5
  This bit indicates the T200 operating mode (local / remote).

- Device trouble - octet 1 - bit 6
  Indicates that the T200 has detected an operating problem.

- Device restart - octet 1 - bit 7
  Indicates restarting of the T200. This enables the Supervisor to know that the database he has relating to the T200 possibly does not reflect reality. As a consequence, he will generally make a request for class 0 objects so as to obtain an exact image of the T200.

- Function code not implemented - octet 2 - bit 0
  The function code received is not managed by the T200.
  This should normally not occur (except in the commissioning phase).

- Requested object(s) unknown - octet 2 - bit 1
  The requested object is unknown to the T200.
  This should normally not occur (except in the commissioning phase).
  By configuration, one can inhibit its management by the T200 (bit always at 0 in this case), because some SCADA systems are disturbed by this bit (see § 4-1 General configuration of the protocol - Management of the requested object unknown bit).

- Error in received parameters - octet 2 - bit 2
  This bit enables the T200 to report any errors of formatting of the received information.
  This should normally not occur (except in the commissioning phase).

- Overflow - octet 2 - bit 3
  Can indicate to the T200 that one of the queues of objects of class 1, 2 or 3 has overflowed and that events have been lost as a consequence.
  The operation of these queues is as follows: An object is placed in the queue that is assigned to it until the queue is saturated. The overflow bit is then marked. New events are no longer stored until the queue, following polling by SCADA, becomes 40% empty again (to avoid any repetitive saturation–desaturation phenomena). It is at this time that the bit goes low.
  It is recommended that following an overflow, the Supervisor, after repatriating all the events, perform reading of the class 0 objects to obtain the real state of the T200.
  Given the large number of objects that the T200 is capable of storing, there is little chance of this situation occurring except through an avalanche of phenomena or a lasting loss of the link between the Supervisor and the T200 (transmission problem or extended SCADA fault).

- Request understood but already being executed - octet 2 - bit 4
  Marking of this bit occurs when the T200 receives a request that has already been made to it and for which it is in the process of performing an action.

- Corrupt configuration - octet 2 - bit 5
  This bit is not managed by the T200.

Bits 6 and 7 of octet 2 are always set to 0 by the T200 (they are reserved for possible concerted use by the Supervisor and remote terminal unit manufacturers).

5.2 Tracing interchange with the Supervisor

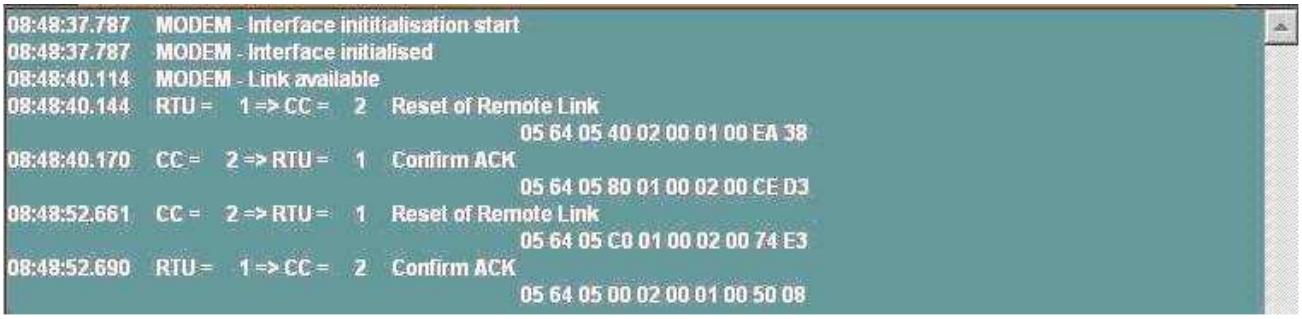
In order to clarify the operation of the protocol, we shall give here a few specific examples of interchange viewed by means of the Trace provided by the T200.

Comment: The following screens were obtained by sending frames step-by-step – so as to show the operation in detail - from a simulator; the time tags are therefore not significant.

- Energizing the T200

  In mode without *Unsolicited Response*

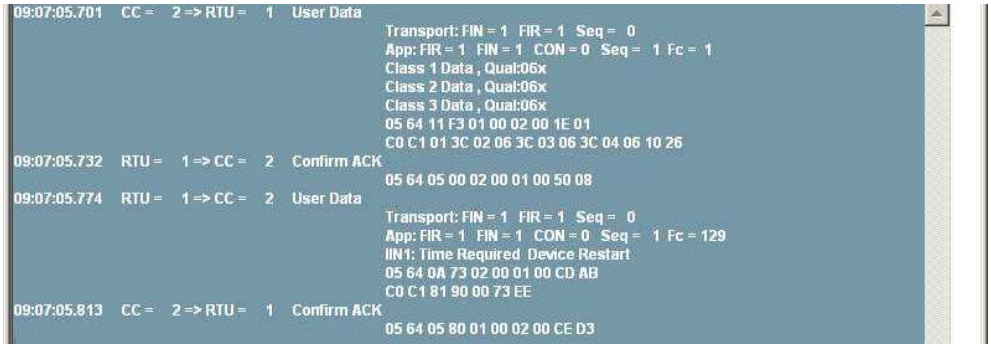
  As soon as the SCADA system tries to establish communication with the T200, it sends a *Reset of remote link* request. So long as the T200 does not respond, the Supervisor repeats this request. Upon receiving the positive confirmation (Ack) sent by the T200, the phase of communication initialization in the Supervisor to T200 direction is completed. The T200 initializes the link in the SCADA to T200 direction (same message sequence but in the opposite direction).


08:48:37.787 MODEM - Interface inititialisation start
08:48:37.787 MODEM - Interface initialised
08:48:40.114 MODEM - Link available
08:48:40.144 RTU = 1 => CC = 2 Reset of Remote Link
05 64 05 40 02 00 01 00 EA 38
08:48:40.170 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3
08:48:52.661 CC = 2 => RTU = 1 Reset of Remote Link
05 64 05 C0 01 00 02 00 74 E3
08:48:52.690 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
Maintenance Page / Port 2

Comment: The frame sequence can be different depending on the end speaking first and the time lag between sending of the 2 *Reset of remote link* requests. With reference to the above case, the following cases can also be found:
CC -> RTU Reset of Remote Link
RTU -> CC Confirm ACK
RTU -> CC Reset of Remote Link
CC -> RTU Confirm ACK
or
RTU -> CC Reset of Remote Link
CC -> RTU Reset of Remote Link
CC -> RTU Confirm ACK
RTU -> CC Confirm ACK
or
CC -> RTU Reset of Remote Link
RTU -> CC Reset of Remote Link
RTU -> CC Confirm ACK
CC -> RTU Confirm ACK
Depending on the response time of the 2 ends, one can also, for the latter two cases, have the 2 positive confirmations in reverse order.

At this stage, the Control Centre doesn't know that the T200 has just started. It knows only that after losing the connection with the T200, it has just been restored.

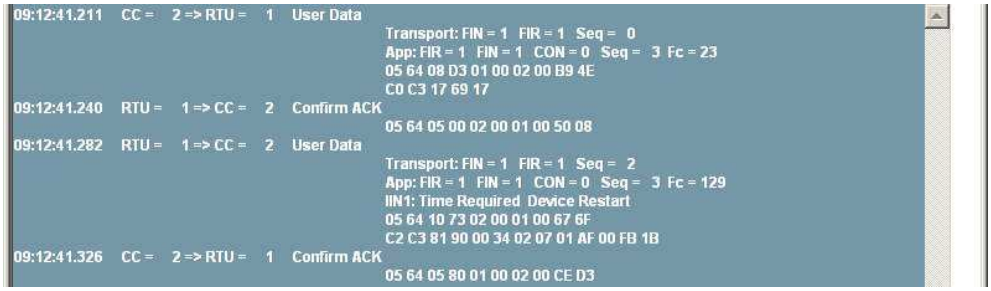
The SCADA system therefore asks the T200 whether the latter has dynamic data (changes) to transmit to it by making a request for objects of classes 1, 2 and 3.


09:07:05.701 CC = 2 => RTU = 1 User Data
Transport: FIN = 1 FIR = 1 Seq = 0
App: FIR = 1 FIN = 1 CON = 0 Seq = 1 Fc = 1
Class 1 Data , Qual:06x
Class 2 Data , Qual:06x
Class 3 Data , Qual:06x
05 64 11 F3 01 00 02 00 1E 01
C0 C1 01 3C 02 06 3C 03 06 3C 04 06 10 26
09:07:05.732 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
09:07:05.774 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 0
App: FIR = 1 FIN = 1 CON = 0 Seq = 1 Fc = 129
IIN1: Time Required Device Restart
05 64 0A 73 02 00 01 00 CD AB
C0 C1 81 90 00 73 EE
09:07:05.813 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3

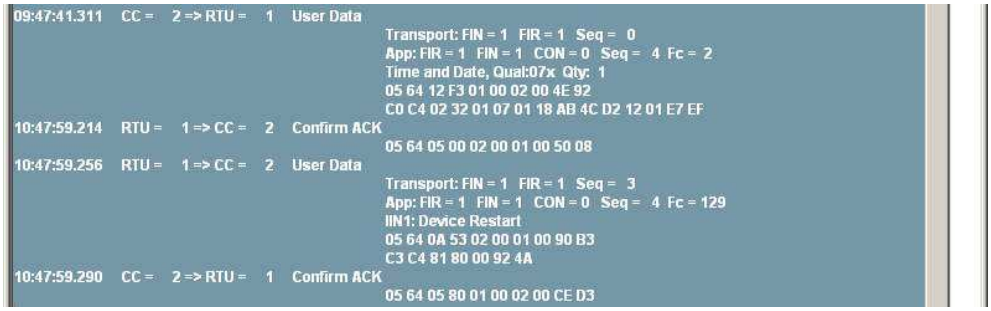
In the two *IIN - Internal Indications* octets that the T200 returns, it indicates by means of the *Device restart* and *Time-synchronisation required from the master* bits that it has just started and that it needs time setting.

Comments:
- Above, the T200 has no class 1, 2 or 3 object to transmit.
- The SCADA system and the T200 are configured, here, to send messages with request for confirmation.
- If the objects are all configured in class 1, the SCADA system may make only one request for *class* 1 objects.

Being now informed of restarting of the T200, the Supervisor will perform time synchronization.
For systems in which the message transmission delay is constant, it is possible to correct synchronization of the transmission delay. The Supervisor then sends a *Delay measurement* message which makes it possible to measure the time required for transmission.

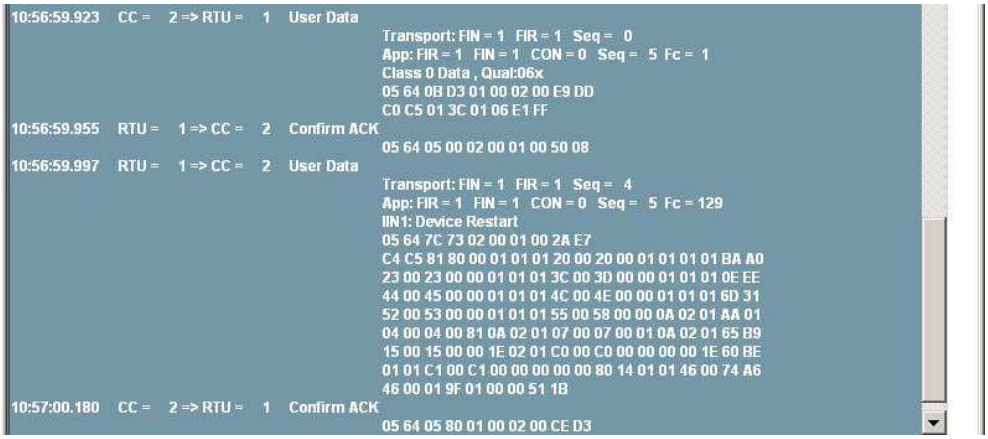

09:12:41.211 CC = 2 => RTU = 1 User Data
Transport: FIN = 1 FIR = 1 Seq = 0
App: FIR = 1 FIN = 1 CON = 0 Seq = 3 Fc = 23
05 64 08 D3 01 00 02 00 B9 4E
C0 C3 17 69 17
09:12:41.240 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
09:12:41.282 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 2
App: FIR = 1 FIN = 1 CON = 0 Seq = 3 Fc = 129
IIN1: Time Required Device Restart
05 64 10 73 02 00 01 00 67 6F
C2 C3 81 90 00 34 02 07 01 AF 00 FB 1B
09:12:41.326 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3

Then, it sends the time setting message (*Write Time and Date*).


09:47:41.311 CC = 2 => RTU = 1 User Data
Transport: FIN = 1 FIR = 1 Seq = 0
App: FIR = 1 FIN = 1 CON = 0 Seq = 4 Fc = 2
Time and Date, Qual:07x Qty: 1
05 64 12 F3 01 00 02 00 4E 92
C0 C4 02 32 01 07 01 18 AB 4C D2 12 01 E7 EF
10:47:59.214 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
10:47:59.256 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 3
App: FIR = 1 FIN = 1 CON = 0 Seq = 4 Fc = 129
IIN1: Device Restart
05 64 0A 53 02 00 01 00 90 B3
C3 C4 81 80 00 92 4A
10:47:59.290 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3

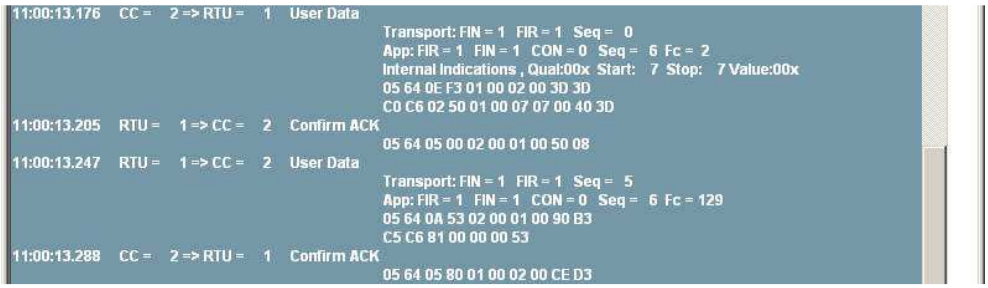
Comment: After time setting, the *Time-synchronisation required from the master* bit is no longer marked in the corresponding *IIN* octet sent by the T200.

The Control Centre will now request all the T200 states so as to have a real image of the T200. To do so, it sends a request for class 0 objects.



The T200 returns all the (static) objects for which a transmission address has been configured.

The Supervisor now has a correct representation of the T200. It can send a reset command for the *Device restart* bit.


11:00:13.176 CC = 2 => RTU = 1 User Data
Transport: FIN = 1 FIR = 1 Seq = 0
App: FIR = 1 FIN = 1 CON = 0 Seq = 6 Fc = 2
Internal Indications , Qual:00x Start: 7 Stop: 7 Value:00x
05 64 0E F3 01 00 02 00 3D 3D
C0 C6 02 50 01 00 07 07 00 40 3D
11:00:13.205 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
11:00:13.247 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 5
App: FIR = 1 FIN = 1 CON = 0 Seq = 6 Fc = 129
05 64 0A 53 02 00 01 00 90 B3
C5 C6 81 00 00 00 53
11:00:13.288 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3

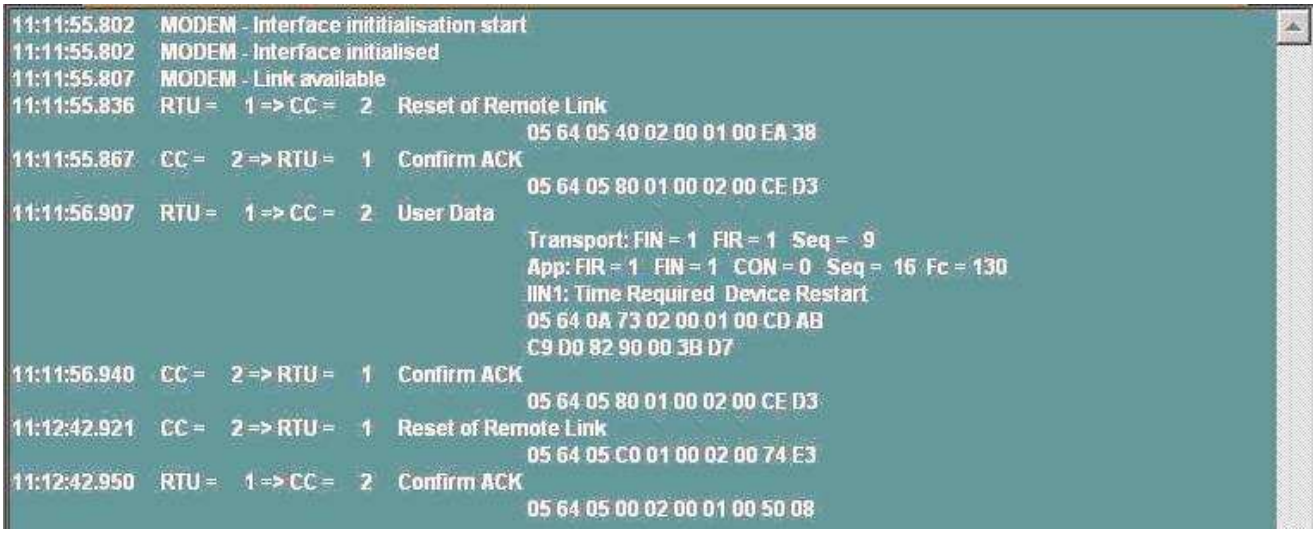
Comment: The latter command can be sent by the Supervisor at any time. In particular, it could have been sent as soon as this bit was seen by the SCADA system. This depends merely on the way in which the Supervisor processes this information.

Then, the Supervisor periodically requests of the T200 the objects of class 1, 2 or 3 (possibly limited to the classes in which objects have been placed).

11:05:38.929 CC = 2 => RTU = 1 User Data
Transport: FIN = 1 FIR = 1 Seq = 0
App: FIR = 1 FIN = 1 CON = 0 Seq = 7 Fc = 1
Class 1 Data , Qual:06x
Class 2 Data , Qual:06x
Class 3 Data , Qual:06x
05 64 11 D3 01 00 02 00 43 19
C0 C7 01 3C 02 06 3C 03 06 3C 04 06 34 51
11:05:38.958 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
11:05:39.001 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 6
App: FIR = 1 FIN = 1 CON = 0 Seq = 7 Fc = 129
05 64 0A 73 02 00 01 00 CD AB
C6 C7 81 00 00 E2 F4
11:05:39.041 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3

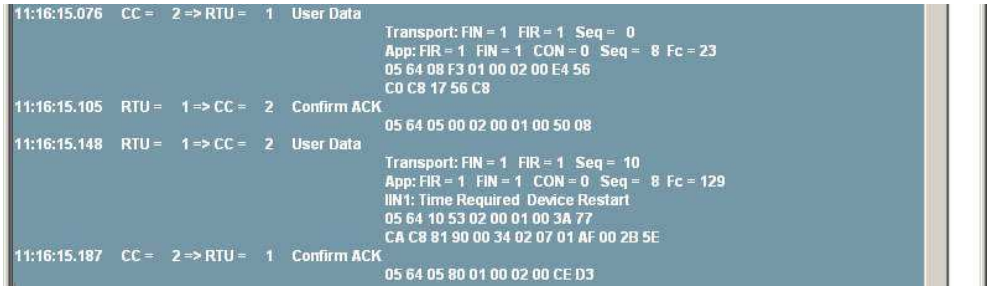
In mode without *Unsolicited Response*

As soon as the SCADA system tries to establish communication with the T200, it sends a *Reset of remote link* request. So long as the T200 does not respond, the Supervisor repeats this request. Upon receiving the positive confirmation (Ack) sent by the T200, the phase of communication initialization in the Supervisor to T200 direction is completed. The T200, for its part, tries to initialize the link in the SCADA to T200 direction (same message sequence but in the opposite direction). As soon as this direction is initialized, the T200 sends the two *IIN - Internal Indications* octets in which it indicates by means of the *Device restart* and *Time-synchronisation required from the master* bits that it has just started and that it needs time setting.

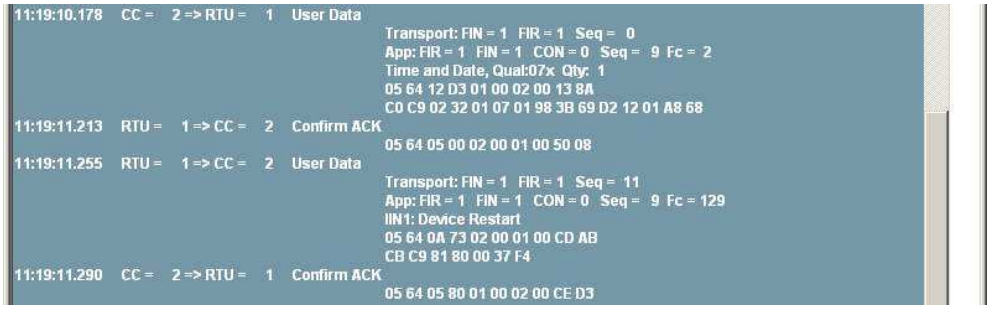

11:11:55.802 MODEM - Interface inititialisation start
11:11:55.802 MODEM - Interface initialised
11:11:55.807 MODEM - Link available
11:11:55.836 RTU = 1 => CC = 2 Reset of Remote Link
05 64 05 40 02 00 01 00 EA 38
11:11:55.867 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3
11:11:56.907 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 9
App: FIR = 1 FIN = 1 CON = 0 Seq = 16 Fc = 130
IIN1: Time Required Device Restart
05 64 0A 73 02 00 01 00 CD AB
C9 D0 82 90 00 3B D7
11:11:56.940 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3
11:12:42.921 CC = 2 => RTU = 1 Reset of Remote Link
05 64 05 C0 01 00 02 00 74 E3
11:12:42.950 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
Maintenance Page / Port 2

Comment: The frame sequence can be different depending on the end speaking first and the time lag between sending of the 2 *Reset of remote link* requests. In particular, it is possible to have, among other things, the *Reset of remote link* sent by the SCADA system and the *Positive confirmation* of the T200 first.

Being now informed of restarting of the T200, the Supervisor will perform time synchronization.
For systems in which the message transmission delay is constant, it is possible to correct synchronization of the transmission delay. The Supervisor then sends a *Delay measurement* message which makes it possible to measure the time required for transmission.

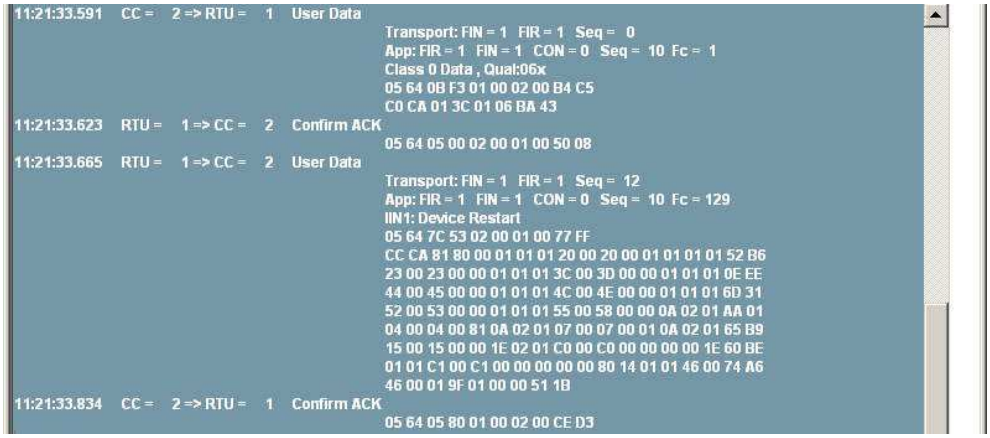

11:16:15.076 CC = 2 => RTU = 1 User Data
Transport: FIN = 1 FIR = 1 Seq = 0
App: FIR = 1 FIN = 1 CON = 0 Seq = 8 Fc = 23
05 64 08 F3 01 00 02 00 E4 56
C0 C8 17 56 C8
11:16:15.105 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
11:16:15.148 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 10
App: FIR = 1 FIN = 1 CON = 0 Seq = 8 Fc = 129
IIN1: Time Required Device Restart
05 64 10 53 02 00 01 00 3A 77
CA C8 81 90 00 34 02 07 01 AF 00 2B 5E
11:16:15.187 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3

Then, it sends the time setting message (*Write Time and Date*).


11:19:10.178 CC = 2 => RTU = 1 User Data
Transport: FIN = 1 FIR = 1 Seq = 0
App: FIR = 1 FIN = 1 CON = 0 Seq = 9 Fc = 2
Time and Date, Qual:07x Qty: 1
05 64 12 D3 01 00 02 00 13 8A
C0 C9 02 32 01 07 01 98 3B 69 D2 12 01 A8 68
11:19:11.213 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
11:19:11.255 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 11
App: FIR = 1 FIN = 1 CON = 0 Seq = 9 Fc = 129
IIN1: Device Restart
05 64 0A 73 02 00 01 00 CD AB
CB C9 81 80 00 37 F4
11:19:11.290 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3

Comment: After time setting, the *Time-synchronisation required from the master* bit is no longer marked in the corresponding *IIN* octet sent by the T200.

The Control Centre will now request all the T200 states so as to have a real image of the T200. To do so, it sends a request for class 0 objects.



The T200 returns all the (static) objects for which a transmission address has been configured.

The Supervisor now has a correct representation of the T200. It can send a reset command for the *Device restart* bit.

11:25:41.822 CC = 2 => RTU = 1 User Data
Transport: FIN = 1 FIR = 1 Seq = 0
App: FIR = 1 FIN = 1 CON = 0 Seq = 11 Fc = 2
Internal Indications , Qual:00x Start: 7 Stop: 7 Value:00x
05 64 0E D3 01 00 02 00 60 25
C0 CB 02 50 01 00 07 07 00 8A C3
11:25:41.852 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
11:25:41.895 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 13
App: FIR = 1 FIN = 1 CON = 0 Seq = 11 Fc = 129
05 64 0A 73 02 00 01 00 CD AB
CD CB 81 00 00 A5 ED
11:25:41.929 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3

Comment: The latter command can be sent by the Supervisor at any time. In particular, it could have been sent as soon as this bit was seen by the SCADA system. This depends merely on the way in which the Supervisor processes this information.

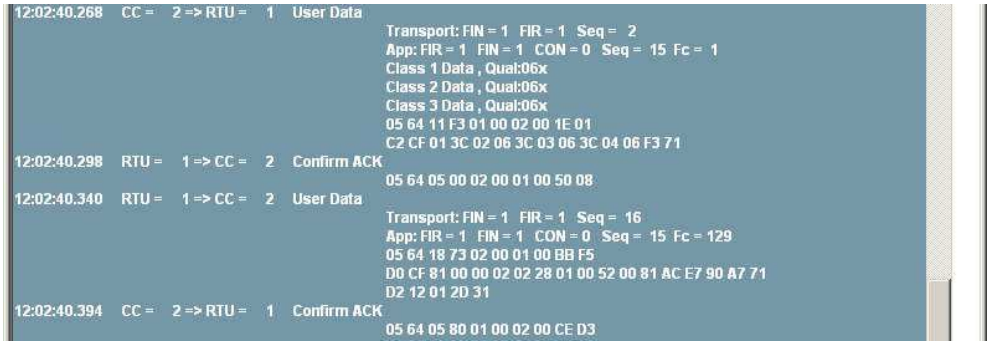
From here on, there are no longer any exchanges between the SCADA system and the T200.

Only a change at the T200 end, or a deliberate action (sending of a command) or automatic action (time synchronization) by the Control Centre will result in resumption of dialogue between the 2 devices.

- Transmission of change of signal

  In mode without *Unsolicited Response*

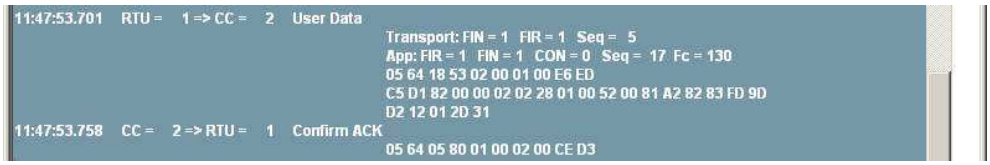
  When a change occurs in response to *polling* by the Supervisor, the T200 transmits the change.



  Above, it is a change of local/remote mode (*Index* 82, or 52 in hexadecimal) that has been sent.

  In *Unsolicited Response* mode

  The T200 sends the change spontaneously without the SCADA needing to send it a request.



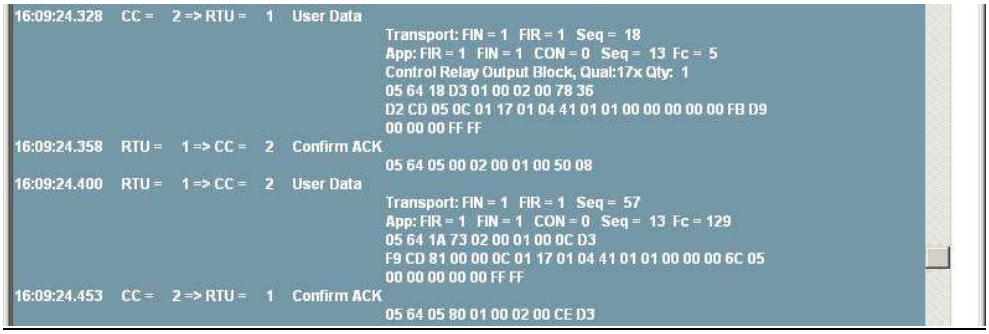
Comment: it is possible to have "mixed" operation. Some objects are placed in a class for which the *Unsolicited Response* mode is authorized, and others in a class for which this mode is not authorized.
In general, objects for which the SCADA system must know any change rapidly (for example, switch opening, fault current flow, etc.), are placed in class 1 for which *Unsolicited Response* is validated, and objects which merely provide operating help (for example, voltage measurement, etc.) are placed in class 2 for which the *Unsolicited Response* function is not validated. The SCADA system is thus, upon calling, informed rapidly of essential events (class 1), while acquiring additional information (class 2) at its own pace.

Telecontrol

In operation without *Unsolicited Response*

- *Direct Operate* mode

The Control Centre interrupts its T200 *polling* to send the command. For this command, there is first an application acknowledgement by the T200. Here, the conditions required for execution of a telecontrol are met (the T200 is in remote mode, there is no command in progress, etc.). The T200 executes the order. The SCADA system continues *polling* on the T200 until change of state is obtained following the command.



Below, one of the Supervisor *polling* operations.

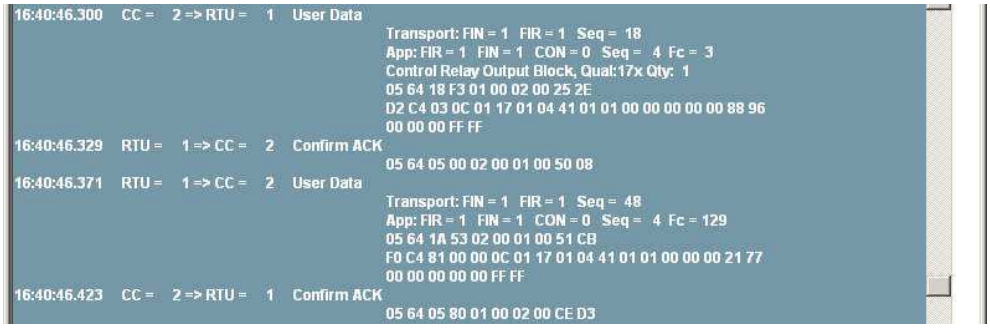
16:09:25.190 CC = 2 => RTU = 1 User Data
Transport: FIN = 1 FIR = 1 Seq = 19
App: FIR = 1 FIN = 1 CON = 0 Seq = 14 Fc = 1
Class 1 Data , Qual:06x
Class 2 Data , Qual:06x
Class 3 Data , Qual:06x
05 64 11 F3 01 00 02 00 1E 01
D3 CE 01 3C 02 06 3C 03 06 3C 04 06 BF 56
16:09:25.219 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
16:09:25.261 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 58
App: FIR = 1 FIN = 1 CON = 0 Seq = 14 Fc = 129
05 64 0A 53 02 00 01 00 90 B3
FA CE 81 00 00 BB A8
16:09:25.295 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3

Comment: The SCADA system could have requested only objects of the class corresponding to the expected object.

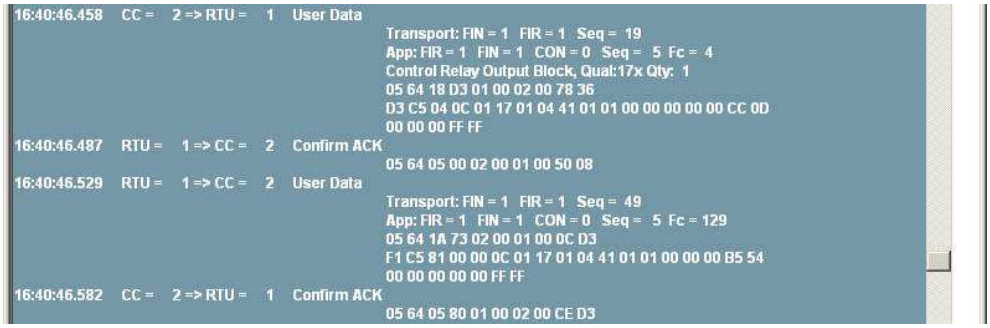
In response to one of the *polling* operations, change of state.

- *Select then Operate* mode

The Supervisor sends the selection of the device it wants to control. The T200 acknowledges by an application.



Then it sends execution, itself acknowledged by an application.



Then comes *polling* to wait for the change of switch position.

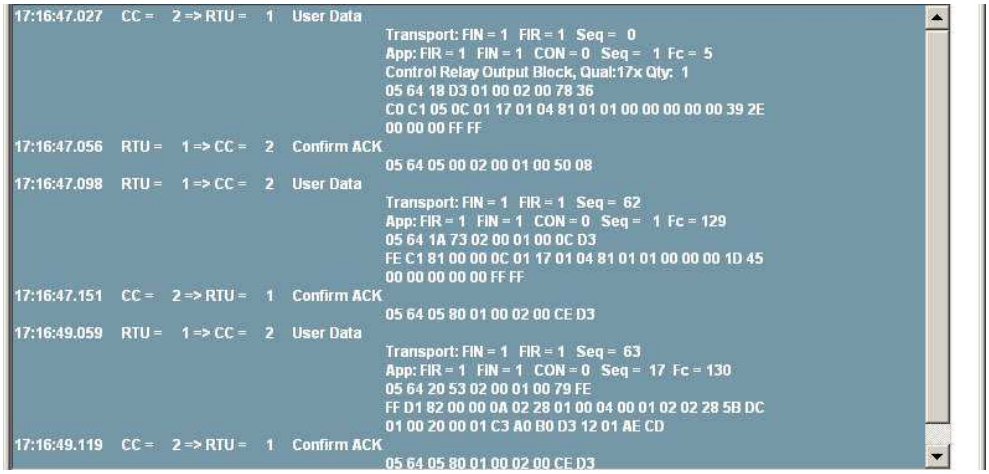
16:40:47.167 CC = 2 => RTU = 1 User Data
Transport: FIN = 1 FIR = 1 Seq = 20
App: FIR = 1 FIN = 1 CON = 0 Seq = 6 Fc = 1
Class 1 Data , Qual:06x
Class 2 Data , Qual:06x
Class 3 Data , Qual:06x
05 64 11 F3 01 00 02 00 1E 01
D4 C6 01 3C 02 06 3C 03 06 3C 04 06 88 FE
16:40:47.196 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
16:40:47.238 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 50
App: FIR = 1 FIN = 1 CON = 0 Seq = 6 Fc = 129
05 64 0A 53 02 00 01 00 90 B3
F2 C6 81 00 00 DD 08
16:40:47.271 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3

Finally, in response to a *polling*, the T200 sends the change of state.

In *Unsolicited Response* operation

- *Direct Operate* mode

The supervisor sends the order. An application confirmation is sent by the T200, followed by the change of position of the device. Below, an order is sent to switch 1 (*Index* 4 – 0004 in hexadecimal). The corresponding change of position (*Index* 32 – 0020 in hexadecimal) is normally returned by the T200.

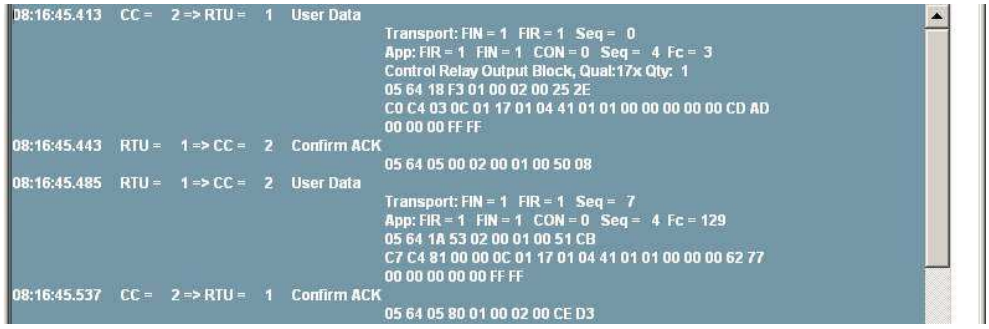


Comment: The exchanges are far more limited than in operation without *Unsolicited Response,* the Supervisor not having to perform *polling* on the T200 to repatriate the change of switch position.

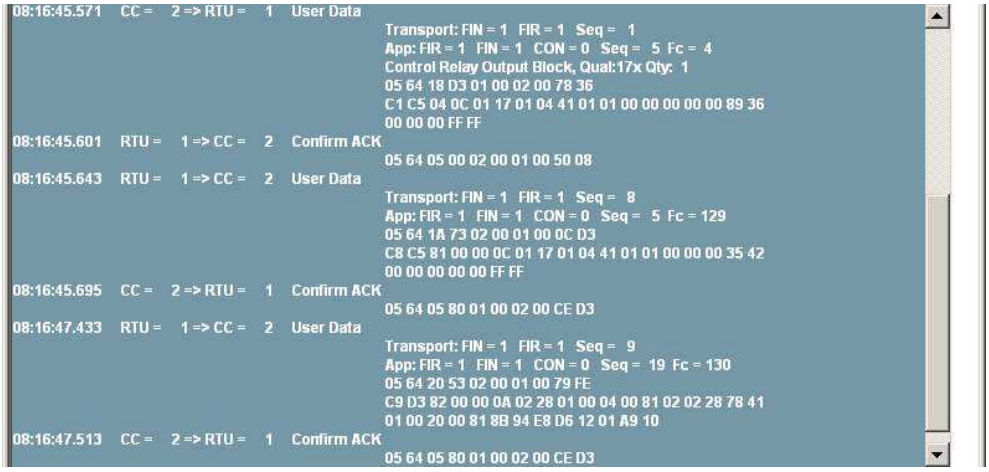
- *Select then Operate* mode

Here again, there are far fewer exchanges than in operation without *Unsolicited Response*.

The Supervisor first performs selection.



Then it sends the execution order which causes the change of position to be sent by the T200.

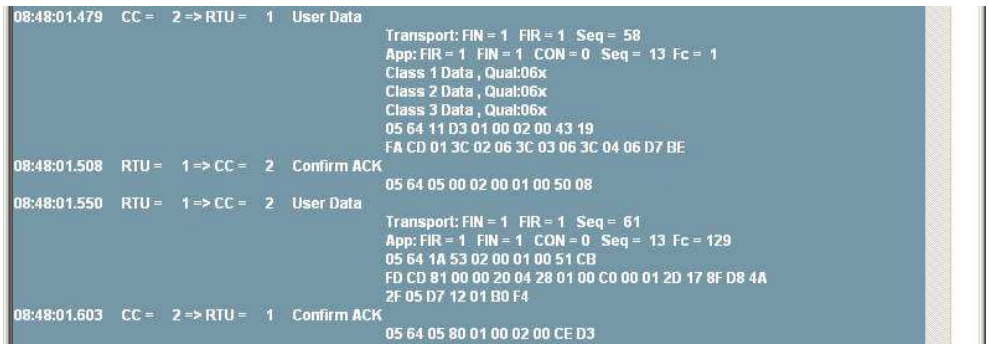


- Cyclic measurement transmission

In mode without *Unsolicited Response*

The SCADA performs its *polling* normally on the T200. From time to time, the T200 records the measurements declared as cyclic and delivers them to the Control Centre in reply to one of its *polling* operations.

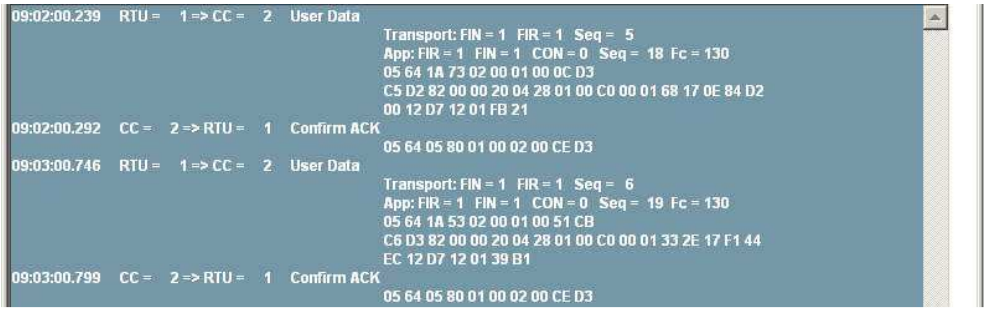
In our case, the measurement of *Index* 192 (00C0 in hexadecimal) has been placed in class 2, the polling delay is set at 1 s and the period between two successive storage in memory operations is set at 1 mn. Since the preceding transmission took place at 8 h 47 mn. 1 s, the following one takes place at 8 h 48 mn. 1 s.



Comment: Although the measurements are cyclic, they cannot be time stamped using the measurement reception time, because it depends on the time of the class 2 user data request and not on the time at which they were stored in memory. The difference between the two may increase with the time difference between 2 SCADA polling operations.

In mode with *Unsolicited Response*

The cyclic measurements are stored in memory and then sent to the SCADA regularly by the T200 without intervention by the Supervisor.



Note that there is no exchange between the 2 measurements sent by the T200. This is characteristic of the *Unsolicited Response* mode.

- Frame repetition

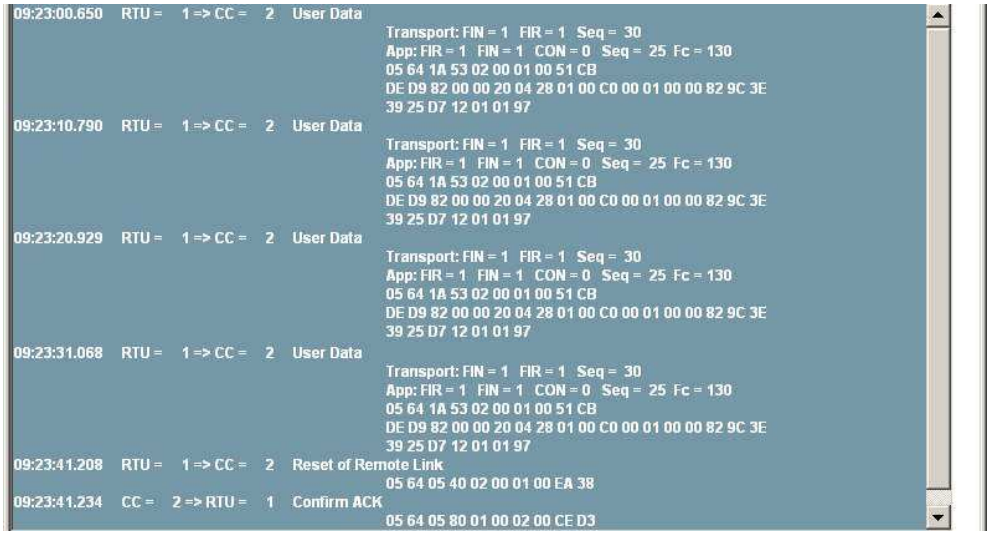
In *Unsolicited Response* mode

We give, here, 2 examples showing the mechanism of frame repetition by the T200, when a transmission problem occurs.

The first case corresponds to a temporary transmission problem, the second to a problem lasting a longer time.

Below, the T200 has not seen the acknowledgement due to a transmission disturbance. As a consequence, the T200 repeats the frame after expiry of the waiting time (the link timeout interval is set to 10 s).

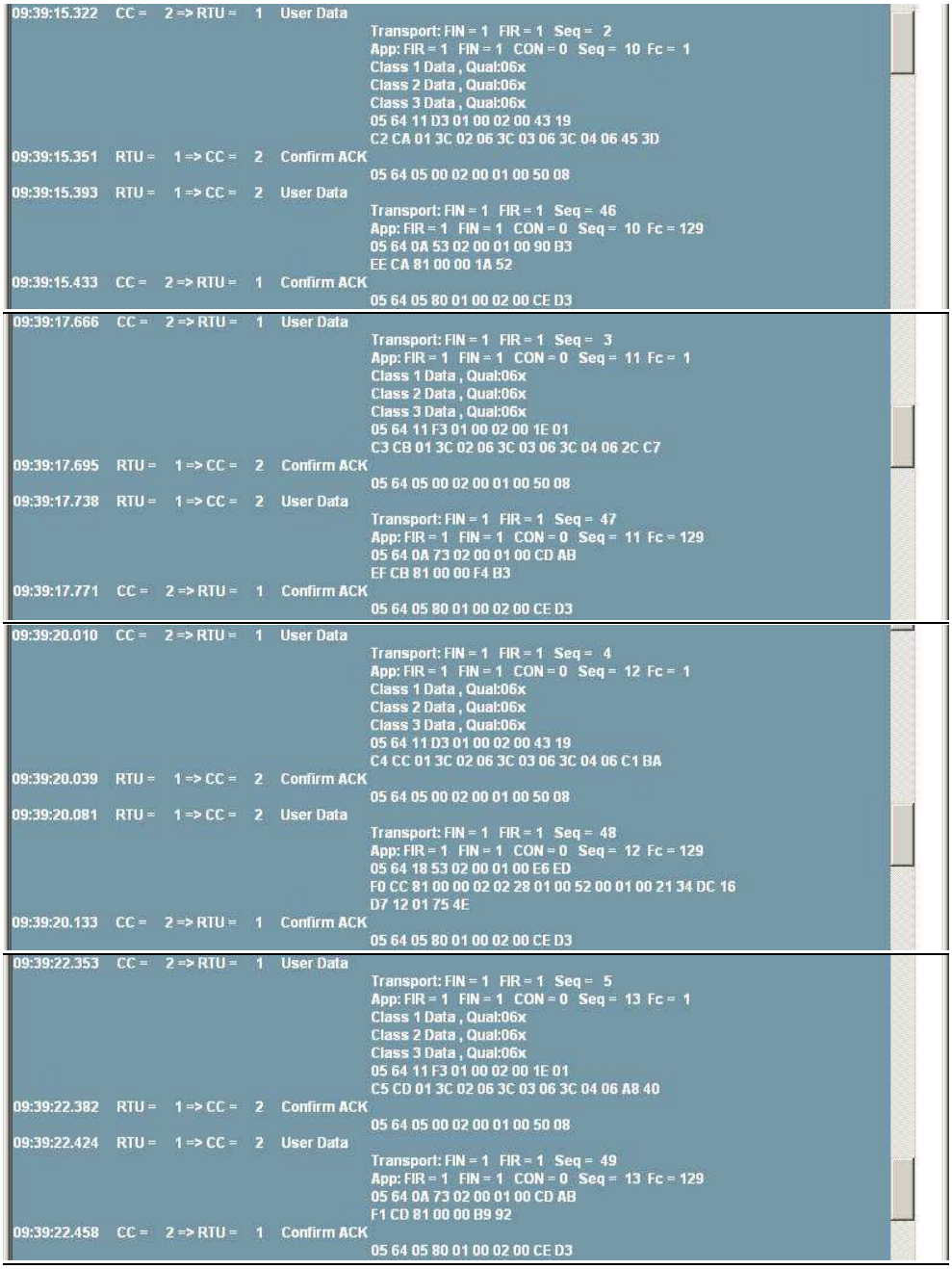
If the disturbance lasts longer, the T200 repeats the frame, complying with the link timeout interval (link timeout here set to 10 s) and the maximum number of repetitions (here set at 3 - i.e. 4 send operations in all). Still having no acknowledgement, it tries to resynchronize with the SCADA system by sending *Reset of remote link* requests.



General comment: The DNP3 protocol, in transmission, by managing in particular a complete transport layer, makes it possible to provide for numerous transmission possibilities. Unfortunately, the disadvantage of this, for medium-sized systems such as the T200, is that a large number of octets must be transmitted for a small quantity of information. This problem is even greater when operating in the mode without *Unsolicited Response*, when using the 3 dynamic classes and the link confirmations.
However, this is not very troublesome when using high transmission speeds.

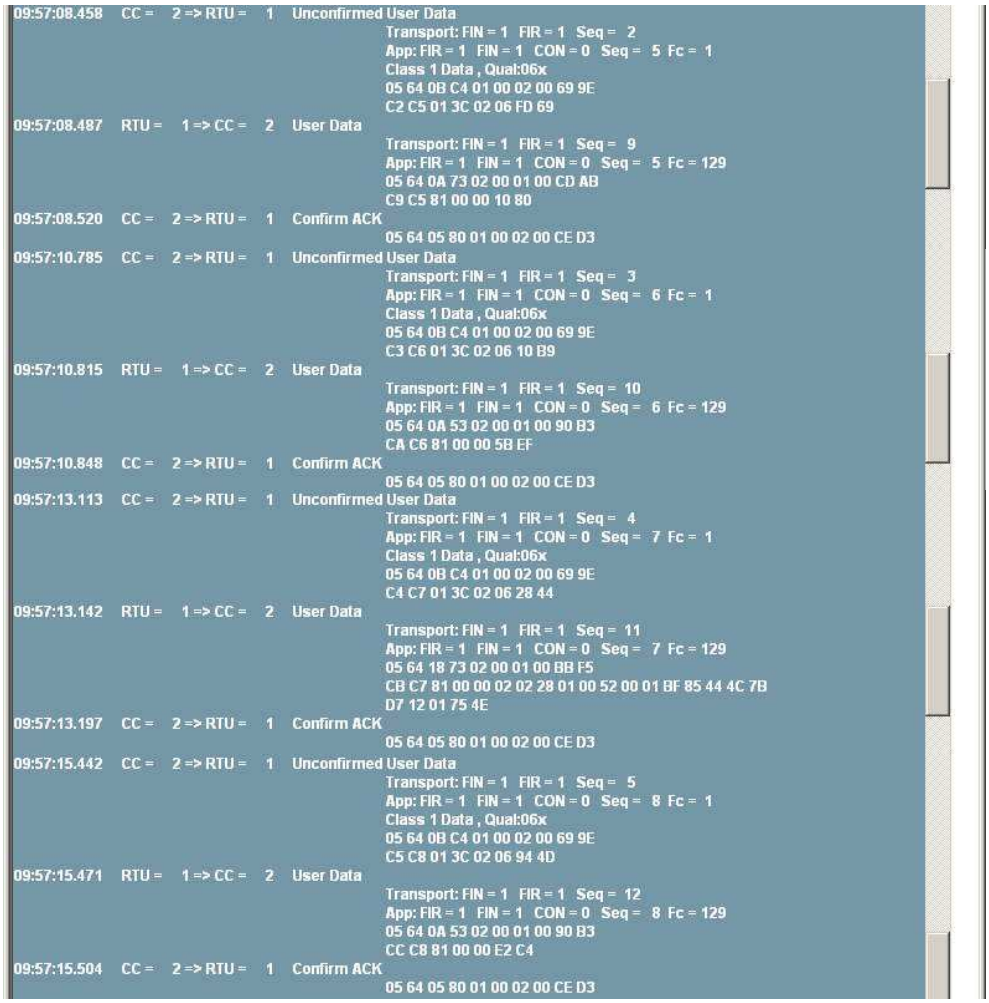
As an example, below are shown several traces corresponding to transmission of the same information - namely transmission of a change of operating mode (local/remote) - in different modes. It will thus be possible to compare the corresponding data interchange volumes.

- Mode without Unsolicited Response, use of the 3 dynamic classes and link confirmations


09:39:15.322 CC = 2 => RTU = 1 User Data
Transport: FIN = 1 FIR = 1 Seq = 2
App: FIR = 1 FIN = 1 CON = 0 Seq = 10 Fc = 1
Class 1 Data , Qual:06x
Class 2 Data , Qual:06x
Class 3 Data , Qual:06x
05 64 11 D3 01 00 02 00 43 19
C2 CA 01 3C 02 06 3C 03 06 3C 04 06 45 3D
09:39:15.351 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
09:39:15.393 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 46
App: FIR = 1 FIN = 1 CON = 0 Seq = 10 Fc = 129
05 64 0A 53 02 00 01 00 90 B3
EE CA 81 00 00 1A 52
09:39:15.433 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3
09:39:17.666 CC = 2 => RTU = 1 User Data
Transport: FIN = 1 FIR = 1 Seq = 3
App: FIR = 1 FIN = 1 CON = 0 Seq = 11 Fc = 1
Class 1 Data , Qual:06x
Class 2 Data , Qual:06x
Class 3 Data , Qual:06x
05 64 11 F3 01 00 02 00 1E 01
C3 CB 01 3C 02 06 3C 03 06 3C 04 06 2C C7
09:39:17.695 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
09:39:17.738 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 47
App: FIR = 1 FIN = 1 CON = 0 Seq = 11 Fc = 129
05 64 0A 73 02 00 01 00 CD AB
EF CB 81 00 00 F4 B3
09:39:17.771 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3
09:39:20.010 CC = 2 => RTU = 1 User Data
Transport: FIN = 1 FIR = 1 Seq = 4
App: FIR = 1 FIN = 1 CON = 0 Seq = 12 Fc = 1
Class 1 Data , Qual:06x
Class 2 Data , Qual:06x
Class 3 Data , Qual:06x
05 64 11 D3 01 00 02 00 43 19
C4 CC 01 3C 02 06 3C 03 06 3C 04 06 C1 BA
09:39:20.039 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
09:39:20.081 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 48
App: FIR = 1 FIN = 1 CON = 0 Seq = 12 Fc = 129
05 64 18 53 02 00 01 00 E6 ED
F0 CC 81 00 00 02 02 28 01 00 52 00 01 00 21 34 DC 16
D7 12 01 75 4E
09:39:20.133 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3
09:39:22.353 CC = 2 => RTU = 1 User Data
Transport: FIN = 1 FIR = 1 Seq = 5
App: FIR = 1 FIN = 1 CON = 0 Seq = 13 Fc = 1
Class 1 Data , Qual:06x
Class 2 Data , Qual:06x
Class 3 Data , Qual:06x
05 64 11 F3 01 00 02 00 1E 01
C5 CD 01 3C 02 06 3C 03 06 3C 04 06 A8 40
09:39:22.382 RTU = 1 => CC = 2 Confirm ACK
05 64 05 00 02 00 01 00 50 08
09:39:22.424 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 49
App: FIR = 1 FIN = 1 CON = 0 Seq = 13 Fc = 129
05 64 0A 73 02 00 01 00 CD AB
F1 CD 81 00 00 B9 92
09:39:22.458 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3

The above sequence is an assembly of several screens, consisting of 2 *polling* operations for which the T200 has no *object* to transmit, followed by 1 *polling* operation with the change in response and a further *polling* operation without *object* to be transmitted by the T200.

- Mode without Unsolicited Response, a single dynamic class and link confirmations in the T200 to SCADA direction only


09:57:08.458 CC = 2 => RTU = 1 Unconfirmed User Data
Transport: FIN = 1 FIR = 1 Seq = 2
App: FIR = 1 FIN = 1 CON = 0 Seq = 5 Fc = 1
Class 1 Data , Qual:06x
05 64 0B C4 01 00 02 00 69 9E
C2 C5 01 3C 02 06 FD 69
09:57:08.487 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 9
App: FIR = 1 FIN = 1 CON = 0 Seq = 5 Fc = 129
05 64 0A 73 02 00 01 00 CD AB
C9 C5 81 00 00 10 80
09:57:08.520 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3
09:57:10.785 CC = 2 => RTU = 1 Unconfirmed User Data
Transport: FIN = 1 FIR = 1 Seq = 3
App: FIR = 1 FIN = 1 CON = 0 Seq = 6 Fc = 1
Class 1 Data , Qual:06x
05 64 0B C4 01 00 02 00 69 9E
C3 C6 01 3C 02 06 10 B9
09:57:10.815 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 10
App: FIR = 1 FIN = 1 CON = 0 Seq = 6 Fc = 129
05 64 0A 53 02 00 01 00 90 B3
CA C6 81 00 00 5B EF
09:57:10.848 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3
09:57:13.113 CC = 2 => RTU = 1 Unconfirmed User Data
Transport: FIN = 1 FIR = 1 Seq = 4
App: FIR = 1 FIN = 1 CON = 0 Seq = 7 Fc = 1
Class 1 Data , Qual:06x
05 64 0B C4 01 00 02 00 69 9E
C4 C7 01 3C 02 06 28 44
09:57:13.142 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 11
App: FIR = 1 FIN = 1 CON = 0 Seq = 7 Fc = 129
05 64 18 73 02 00 01 00 BB F5
CB C7 81 00 00 02 02 28 01 00 52 00 01 BF 85 44 4C 7B
D7 12 01 75 4E
09:57:13.197 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3
09:57:15.442 CC = 2 => RTU = 1 Unconfirmed User Data
Transport: FIN = 1 FIR = 1 Seq = 5
App: FIR = 1 FIN = 1 CON = 0 Seq = 8 Fc = 1
Class 1 Data , Qual:06x
05 64 0B C4 01 00 02 00 69 9E
C5 C8 01 3C 02 06 94 4D
09:57:15.471 RTU = 1 => CC = 2 User Data
Transport: FIN = 1 FIR = 1 Seq = 12
App: FIR = 1 FIN = 1 CON = 0 Seq = 8 Fc = 129
05 64 0A 53 02 00 01 00 90 B3
CC C8 81 00 00 E2 C4
09:57:15.504 CC = 2 => RTU = 1 Confirm ACK
05 64 05 80 01 00 02 00 CE D3

The above sequence is again an assembly of several screens, consisting of 2 *polling* operations for which the T200 has no *object* to transmit, followed by 1 *polling* operation with the change in response and a further *polling* operation without *object* to be transmitted by the T200.

It can be observed that the volume of octets exchanged is far smaller.

- Unsolicited Response mode, a single dynamic class and link confirmations in the T200 to SCADA direction only

Here, the exchanges are greatly reduced (there is no longer any need for *polling*).

6. Glossary

B

Binary Input
Single and double signals are treated as objects of the *Binary Input* type.

Broadcast
The Supervisor can send a message to all the remote terminal units. This is called *broadcasting.* The *Destination Address* in that case equals 65535. In this case, the addressees will not reply to the received frame (the service used is then, mandatorily, the *Send/No reply expected* service).

C

Class
The *objects* are broken down into 4 classes.
- *Class* 0 is assigned to static *objects* – a static *object* corresponding to the state of an item at a given time (single signal, measured value, etc.). The supervisor therefore makes a request for class 0 *objects* to obtain a complete and representative image of the T200 at a given time.
- Classes 1, 2 and 3 are used for dynamic *objects* - a dynamic *object* corresponding to an event relating to a static *object* (change of signal, threshold crossing by a measurement, etc.).
The dynamic class of an object is configured in the window relating to the variable (Parameters Setup Page / Variable Configuration / name_of_variable), under the External Address heading. This address is entered in the form "address,class". For example: 251,2 will be put for an object of *Index* 251 and *class* 2. By default, all dynamic *objects* are placed in *class* 1. As a result, the "address,1" configuration is equivalent to the "address" configuration.
The user is free to use the dynamic classes as he wants. He may use only a single dynamic class if he wants.
When performing a breakdown into the 3 classes, important items (switch position, fault current flow, etc.) are generally placed in class 1, operating help items (current value, voltage, etc.) in class 2 and items of a maintenance or statistical nature (number of switch operations, active energy, etc.) in class 3.
This makes it possible, when operating without *Unsolicited Response*, to have rapid *polling* on class 1 (to be rapidly informed of any major change on the telecontrol network), to have less rapid polling on class 2 (every 15 min., for example), and slow polling on class 3 (every day, every month, etc.).
In *Unsolicited Response* mode, the advantage is slighter, except if this mode is authorized for one class and not for the others. One can then have all types of organization combining *Unsolicited Response* operation (for class 1, for example), polling (for class 2, for example) and reading at the request of the operator (class 3, for example).

Clock synchronization
This function is used by the Supervisor to perform date and time setting for the remote terminal units. When the transmission time is constant, the Supervisor can proceed in 2 steps: a first step to acquire the transmission delay, and a second to perform synchronization (the T200 in that case correcting the transmission delay). If the transmission time is not constant, the Supervisor will perform only the second step.

Client / Serveur Architecture
Process used to exchange DNP3 messages over an IP network using TCP protocol. In our case, the T200 is associated to the server, the supervisor to the client.

D

Data Object
Every information item transmitted is called an *object*. An object can be static (state of an item) or dynamic (change of an item). For example, the T200 will use the "Binary Input with Status" object to transmit the state of a double signal and the "Binary Input Change with Time" object to transmit a change in the same signal.
Static objects belong to class 0, dynamic objects to one of the classes 1, 2 and 3.

Delay Measurement
To perform *time synchronization*, the Supervisor, when the transmission time is constant, can send a *Delay Measurement* message, which will make it possible to measure this time and thus perform synchronization via the *Write Time and Date* message by correcting the transmission delay.

Destination Address
Exchanges between the T200 and the SCADA system contain a *Source Address* which specifies the sender of the message and a *Destination Address* which indicates for whom the message is destined. These addresses are coded on 2 octets.
The *Destination Address*
- For messages sent by the T200, is the address of the SCADA system. In that case it is configured in the SCADA Address section. It can take any value between 0 and 65534.
- For messages received by the T200 and which are destined for it, it corresponds to its own identification address. It is configured in the Device Address section. It can take any value between 0 and 65534.
The value 65535 is reserved as *Destination Address* for *broadcast* messages (messages destined for all the devices). The *broadcast* address can, for example, be used by the Supervisor for time setting of all remote terminal units.

Device restart
Bit 7 of the first octet of the *Internal Indications* (*IIN*) indicating that the T200 has just started. It is reset by the Supervisor.

Direct operate
In this command execution mode, the command, when it is authorized, is executed upon receiving this message. The wanted selection relay is actuated, and, after verification, it is the turn of the execution relay. During all the command sequences, checks are performed. Any detected anomaly causes immediate stoppage of the command.

E
Enhanced Performance Architecture
3-layer transmission model used in the IEC 60870-5-101 standard (simplified version of the 7-layer ISO model).

G
Global Request
The Supervisor can send a message to all the remote terminal units (for time setting, for example). This type of message is called a *Global Request*. It contains, as *Destination Address*, the address 65535. This address is called the *broadcast* address. To avoid all the remote terminal units responding at the same time, the Supervisor uses the *Send/No reply expected* function. When a T200 sends its next information frame, it will set in the *Internal Indications* the "All stations message received" bit to indicate that the message has been received correctly.

I
Index
In DNP3, the address defining an object in transmission is called the *Index*. It is configured in the "External address" section at the same time as the dynamic *class* of the *object*, in the form "address,class". This address can be represented on 1 or 2 octets (8 or 16 bits), this being selected in the "Object Address" section.

Internal Indications (IIN)
In data interchange between the T200 and the Supervisor, the T200 gives an indication of its general state in 2 octets called *Internal Indications*. There it indicates, among other things, that it has received a *broadcast* message, that it has *class* 1, 2 or 3 data to be transmitted, that it has just restarted, that the time is no longer set, etc.

O
On-line
Bit of the *Status* octet for a "Binary Input with Status", used by the T200 to indicate a complementarity fault when it handles a double signal. This bit is set to 0 in the case of non-complementarity.

P
Polling
This word designates a method for repatriation of information from the T200.
The Supervisor interrogates each T200 in succession so that it may return its information. Since the information *objects* may be distributed among several classes, it is possible for the SCADA system to retrieve these objects at different rates.

Positive confirmation
Message returned following receipt of a frame to confirm to the sender that it has been received correctly. Also called Ack (for Acknowledge).

R

Reading
The Supervisor works by *Reading* or *Writing* data to or from the remote terminal units.

Reading Class 0 data
This message, sent by the Supervisor, enables it to acquire the complete state of the T200 at the time of interrogation. The T200 sends back, in reply, all the static objects for which an external address (*Index*) has been configured.

Requested object(s) unknown
This bit transmitted in the *Internal Indications* allows the T200 to indicate that it does not handle the requested *object*. This bit disturbs some Supervisors. To avoid this problem, it is possible to deactivate it by the configuration settings in the "Requested object(s) unknown bit management" section.

Reset of remote link
Sent frame allowing resynchronization of the 2 ends of a link for a direction of communication.

S

Select then Operate
In this command execution mode, the command, when it is authorized, is executed in two stages. The T200 first receives a select message. It then receives an execute message. It then checks that the same device is involved. If this check is satisfactory, it executes the command sequence. Throughout the command's duration, checks are performed. Any detected anomaly causes immediate stoppage of the command. Moreover, if, after receiving the select message, an excessive time elapses without the T200 receiving the execute message, the command is cancelled. This time is configured in the Selection Timeout section.

Send / Confirm expected
When the sender uses this transmission service, the receiver must confirm to it that it has received the frame.

Send / No reply expected
When the sender uses this transmission service, it expects no confirmation by the receiver of correct frame reception.

Source Address
Exchanges between the T200 and the SCADA system contain a *Source Address* which specifies the sender of the message and a *Destination Address* which indicates for whom the message is destined. These addresses are coded on 2 octets.
Source Address
- for messages sent by the T200, this is the address which allows the T200 of identify itself on the network. It is configured in the Device Address section. It can take any value between 0 and 65534.
- for messages received by the T200, it corresponds to the address of the SCADA system. It is configured in the SCADA Address section. It can take any value between 0 and 65534.

Serveur/Client Architecture
Process used to exchange DNP3 messages over an IP network using TCP protocol. In our case, the T200 is associated to the server, the supervisor to the client

State
Bit representing the state of a *binary input*.

Status
Octet representing a "Binary Input with Status" *object*. This octet contains, among other things, the *State* bit which gives the *Binary Input* state.

T

Time-synchronisation required from the master
Bit 4 of the first octet of the *Internal Indications* (*IIN*) indicating that the T200 needs date and time setting. This bit is marked after T200 energizing or when a period exceeding the time configured in the "Clock Validity" section has elapsed since the last time setting.

TCP
Transport Control Protocol.
Protocol used over an IP link which can be used by the T200 for the DNP3 IP protocol.

U

Unsolicited Response
The basic operation of the DNP3 Protocol is of the master-slave type, in which the Supervisor is master and the remote terminal units are the slaves. However, when *Unsolicited Response* operation is validated, the remote terminal units are authorized to call the Supervisor and in that case act as master.
In the T200, when *Unsolicited Response* is enabled, one can select the classes for which this operation is permitted.
One can thus have all possible organizations between operation without *Unsolicited Response* (the simplest to manage at the Supervisor end - because the latter completely controls the transmission load - but the most restrictive with regard to the transmission media) and operation in which all the classes used are declared as operating in *Unsolicited Response* mode (the hardest to manage at the Supervisor end - because the Supervisor no longer has control over the dialogue load - and at the remote terminal unit end - because the latter must manage a collision avoidance system – but which does not heavily load the transmission media).

UDP
User Datagram Protocol.
Protocol used over an IP link which can be used by the T200 for the DNP3 IP protocol.

W

Write Time and Date
Time setting message sent by the Supervisor. This date and time setting can be corrected, when the transmission delay is constant, for this transmission time.

Writing
The Supervisor works by *Writing* or *Reading* data to or from the remote terminal units.

7. Interoperability Documents

7.1 Implementation Table

OBJECT			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes (dec)	Qual Codes (hex)
1	0	Binary Input - All Variations	1, 22	00, 01, 06		
1	1	Binary Input	1	00, 01, 06	129, 130	00, 01
1	2	Binary Input with Status	1	00, 01, 06	129, 130	00, 01
2	0	Binary Input Change - All Variations	1	06, 07, 08		
2	1	Binary Input Change without Time	1	06, 07, 08	129, 130	17, 28
2	2	Binary Input Change with Time	1	06, 07, 08	129, 130	17, 28
2	3	Binary Input Change with Relative Time	1	06, 07, 08	129, 130	17, 28
10	0	Binary Output - All Variations	1	00, 01, 06		
10	1	Binary Output				
10	2	Binary Output Status	1	00, 01, 06	129, 130	00, 01
12	0	Control Block - All Variations				
12	1	Control Relay Output Block	3, 4, 5, 6	17, 28	129	echo of request
12	2	Pattern Control Block	5, 6	17, 28	129	echo of request
12	3	Pattern Mask	5, 6	00, 01	129	echo of request
20	0	Binary Counter - All Variations	1, 7, 8 9, 10, 22	00, 01, 06		
20	1	32-Bit Binary Counter	1	00, 01, 06	129, 130	00, 01
20	2	16-Bit Binary Counter	1	00, 01, 06	129, 130	00, 01
20	3	32-Bit Delta Counter	1	00, 01, 06	129, 130	00, 01
20	4	16-Bit Delta Counter	1	00, 01, 06	129, 130	00, 01
20	5	32-Bit Binary Counter without Flag	1	00, 01, 06	129, 130	00, 01
20	6	16-Bit Binary Counter without Flag	1	00, 01, 06	129, 130	00, 01
20	7	32-Bit Delta Counter without Flag	1	00, 01, 06	129, 130	00, 01
20	8	16-Bit Delta Counter without Flag	1	00, 01, 06	129, 130	00, 01

OBJECT			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes (dec)	Qual Codes (hex)
21	0	Frozen Counters - All Variations	1, 22	00, 01, 06		
21	1	32-Bit Frozen Counter	1	00, 01, 06	129, 130	00, 01
21	2	16-Bit Frozen Counter	1	00, 01, 06	129, 130	00, 01
21	3	32-Bit Frozen Delta Counter	1	00, 01, 06	129, 130	00, 01
21	4	16-Bit Frozen Delta Counter	1	00, 01, 06	129, 130	00, 01
21	5	32-Bit Frozen Counter with Time of Freeze				
21	6	16-Bit Frozen Counter with Time of Freeze				
21	7	32-Bit Frozen Delta Counter with Time of Freeze				
21	8	16-Bit Frozen Delta Counter with Time of Freeze				
21	9	32-Bit Frozen Counter without Flag	1	00, 01, 06	129, 130	00, 01
21	10	16-Bit Frozen Counter without Flag	1	00, 01, 06	129, 130	00, 01
21	11	32-Bit Frozen Delta Counter without Flag				
21	12	16-Bit Frozen Delta Counter without Flag				
22	0	Counter Change Event - All Variations	1	06, 07, 08		
22	1	32-Bit Counter Change Event without Time	1	06, 07, 08	129, 130	17, 28
22	2	16-Bit Counter Change Event without Time	1	06, 07, 08	129, 130	17, 28
22	3	32-Bit Delta Counter Change Event without Time	1	06, 07, 08	129, 130	17, 28
22	4	16-Bit Delta Counter Change Event without Time	1	06, 07, 08	129,130	17, 28
22	5	32-Bit Counter Change Event with Time				
22	6	16-Bit Counter Change Event with Time				
22	7	32-Bit Delta Counter Change Event with Time				
22	8	16-Bit Delta Counter Change Event with Time				

OBJECT			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj	**Var**	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**
23	0	Frozen Counter Events - All Variations	1	06, 07, 08		
23	1	32-Bit Frozen Counter Event without Time	1	06, 07, 08	129, 130	17, 28
23	2	16-Bit Frozen Counter Event without Time	1	06, 07, 08	129, 130	17, 28
23	3	32-Bit Frozen Delta Counter Event without Time	1	06, 07, 08	129, 130	17, 28
23	4	16-Bit Frozen Delta Counter Event without Time	1	06, 07, 08	129, 130	17, 28
23	5	32-Bit Frozen Counter Event with Time				
23	6	16-Bit Frozen Counter Event with Time				
23	7	32-Bit Frozen Delta Counter Event with Time				
23	8	16-Bit Frozen Delta Counter Event with Time				
30	0	Analog Input - All Variations	1, 22	00, 01, 06		
30	1	32-Bit Analog Input	1	00, 01, 06	129, 130	00, 01
30	2	16-Bit Analog Input	1	00, 01, 06	129, 130	00, 01
30	3	32-Bit Analog Input without flag	1	00, 01, 06	129, 130	00, 01
30	4	16-Bit Analog Input without flag	1	00, 01, 06	129, 130	00, 01
31	0	Frozen Analog Input - All Variations				
31	1	32-Bit Frozen Analog Input				
31	2	16-Bit Frozen Analog Input				
31	3	32-Bit Frozen Analog Input with Time of Freeze				
31	4	16-Bit Frozen Analog Input with Time of Freeze				
31	5	32-Bit Frozen Analog Input without Flag				
31	6	16-Bit Frozen Analog Input without Flag				

OBJECT			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj	**Var**	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**
32	0	Analog Change Event - All Variations	1	06, 07, 08		
32	1	32-Bit Analog Change Event without Time	1	06, 07, 08	129, 130	17, 28
32	2	16-Bit Analog Change Event without Time	1	06, 07, 08	129, 130	17, 28
32	3	32-Bit Analog Change Event with Time				
32	4	16-Bit Analog Change Event with Time				
33	0	Frozen Analog Event - All Variations				
33	1	32-Bit Frozen Analog Event without Time				
33	2	16-Bit Frozen Analog Event without Time				
33	3	32-Bit Frozen Analog Event with Time				
33	4	16-Bit Frozen Analog Event with Time				
40	0	Analog Output Status - All Variations	1	00, 01, 06		
40	1	32-Bit Analog Output Status	1	00, 01,0 6	129, 130	00, 01
40	2	16-Bit Analog Output Status	1	00, 01,0 6	129, 130	00, 01
41	1	32-Bit Analog Output Block	3, 4, 5, 6	17, 28	129	echo of request
41	2	16-Bit Analog Output Block	3, 4, 5, 6	17, 28	129	echo of request
50	0	Time and Date - All Variations				
50	1	Time and Date	2 (see 4.14)	07 where quantity = 1		
			1	07 where quantity = 1	129	07 where quantity = 1
50	2	Time and Date with Interval				

OBJECT			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj	**Var**	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**
51	0	Time and Date CTO - All Variations				
51	1	Time and Date CTO			129, 130	07 where quantity = 1
51	2	Unsynchronized Time and Date CTO			129, 130	07 where quantity = 1
52	0	Time Delay - All Variations				
52	1	Time Delay Coarse			129	07 where quantity = 1
52	2	Time Delay Fine			129	07 where quantity = 1
60	0	Not Defined				
60	1	Class 0 Data	1	06		
60	2	Class 1 Data	1	06, 07, 08		
			20, 21, 22	06		
60	3	Class 2 Data	1	06, 07, 08		
			20, 21, 22	06		
60	4	Class 3 Data	1	06, 07, 08		
			20, 21, 22	06		
70	1	File Identifier				
80	1	Internal Indications	1	00, 01		
			2	00 index = 7		
81	1	Storage Object				
82	1	Device Profile				
83	1	Private Registration Object				
83	2	Private Registration Object Descriptor				
90	1	Application Identifier				
100	1	Short Floating Point				
100	2	Long Floating Point				
100	3	Extended Floating Point				

OBJECT			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj	**Var**	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**
101	1	Small Packed Binary-Coded Decimal				
101	2	Medium Packed Binary-Coded Decimal				
101	3	Large Packed Binary-Coded Decimal				
		No object	13			
		No object	23 (see 4.14)			

7.2 Device Profile Document

<table>
<tr><td colspan="2">DNP V3.00
DEVICE PROFILE DOCUMENT</td></tr>
<tr><td>Vendor Name:</td><td>SCHNEIDER ELECTRIC</td></tr>
<tr><td>Device Name:</td><td>T200 Series 3</td></tr>
<tr><td>Highest DNP Level Supported:

For Requests: L3

For Responses: L3</td><td>Device Function:

☐ Master ☑ Slave</td></tr>
<tr><td colspan="2">Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):</td></tr>
<tr><td>Maximum Data Link Frame Size (octets):

Transmitted: 292

Received: (must be 292)</td><td>Maximum Application Fragment Size (octets):

Transmitted: 2048 (if > 2048, must be configurable)

Received: 2048 (must be ≥ 249)</td></tr>
<tr><td>Maximum Data Link Re-tries:

☐ None
☐ Fixed at _____
☑ Configurable, range 0 to 10</td><td>Maximum Application Layer Re-tries:

☑ None
☐ Configurable, range 0 to 10
(Fixed is not permitted)</td></tr>
</table>

Requires Data Link Layer Confirmation:

☐ Never
☐ Always
☐ Sometimes If 'Sometimes', when? _____
☑ Configurable If 'Configurable', how? Always or Never selected through configuration software

Requires Application Layer Confirmation:

☐ Never
☐ Always (not recommended)
☑ When reporting Event Data (Slave devices only)
☐ When sending multi-fragment responses (Slave devices only)

☐ Sometimes If 'Sometimes', when? _____
☑ Configurable If 'Configurable', how? Never or When reporting Event selected through configuration software

Timeouts while waiting for:

Data Link Confirm	☐ None	☐ Fixed at ____	☐ Variable	☑ Configurable
Complete Appl. Fragment	☑ None	☐ Fixed at ____	☐ Variable	☐ Configurable
Application Confirm	☐ None	☐ Fixed at ____	☐ Variable	☑ Configurable
Complete Appl. Response	☑ None	☐ Fixed at ____	☐ Variable	☐ Configurable

Others _____

When 'Configurable' – value selected through configuration software

Sends/Executes Control Operations:

WRITE Binary Outputs	☑ Never	☐ Always	☐ Sometimes	☐ Configurable
SELECT/OPERATE	☐ Never	☑ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE	☐ Never	☑ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE – NO ACK	☐ Never	☑ Always	☐ Sometimes	☐ Configurable
Count > 1	☑ Never	☐ Always	☐ Sometimes	☐ Configurable
Pulse On (1)	☐ Never	☐ Always	☑ Sometimes	☐ Configurable
Pulse Off	☑ Never	☐ Always	☐ Sometimes	☐ Configurable
Latch On	☐ Never	☑ Always	☐ Sometimes	☐ Configurable
Latch Off	☐ Never	☑ Always	☐ Sometimes	☐ Configurable
Queue	☑ Never	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	☑ Never	☐ Always	☐ Sometimes	☐ Configurable

(1) only with Trip or Close – delay value set through configuration software.

<table>
<tr><th colspan="2">FILL OUT THE FOLLOWING ITEMS FOR MASTER DEVICES ONLY:</th></tr>
<tr><td colspan="2">Expects Binary Input Change Events:

☐ Either time-tagged or non-time-tagged for a single event
☐ Both time-tagged and non-time-tagged for a single event
☐ Configurable (attach explanation)</td></tr>
<tr><th colspan="2">FILL OUT THE FOLLOWING ITEMS FOR SLAVE DEVICES ONLY:</th></tr>
<tr><td>Reports Binary Input Change Events when no specific variation requested:

☐ Never
☑ Only time-tagged
☐ Only non-time-tagged
☐ Configurable to send both, one or the other (attach explanation)</td><td>Reports time-tagged Binary Input Change Events when no specific variation requested:

☐ Never
☑ Binary Input Change With Time
☐ Binary Input Change With Relative Time
☐ Configurable (attach explanation)</td></tr>
<tr><td>Sends Unsolicited Responses:

☑ Never
☐ Configurable (attach explanation)
☐ Only certain objects
☐ Sometimes (attach explanation)

☐ ENABLE/DISABLE UNSOLICITED Function codes supported</td><td>Sends Static Data in Unsolicited Responses:

☑ Never
☐ When Device Restarts
☐ When Status Flags Change

No other options permitted.</td></tr>
<tr><td>Default Counter Object/Variation:

☐ No Counters Reported
☐ Configurable (attach explanation)
☑ Default Object 20
Default Variation 01
☐ Point-by-point list attached</td><td>Counters Roll Over at:

☐ No Counters Reported
☐ Configurable (attach explanation)
☐ 16 Bits
☐ 32 Bits
☑ Other Value 9 999 999
☐ Point-by-point list attached</td></tr>
<tr><td colspan="2">Sends Multi-Fragment Responses: ☑ Yes ☐ No</td></tr>
</table>

7.3 Control Relay

Control code for Control Relay Output Block	This octet contains different parameters describing the command (refer to standard DNP V3.00 for details), and only some combinations are accepted by the equipment. The accepted combinations are: 0x03 : code = 3, "Latch On", Trip/close= '00' --> Close operation 0x04 : code = 4, "Latch Off", Trip/close= '00' --> Open operation 0x41: code = 1,"Pulse On", Trip/close = '01' --> Close operation 0x81: code = 1,"Pulse On", Trip/close = '10' --> Open operation Other values of the Control Code will be rejected with the status 3 (Request not accepted) Concerning the other parameters of the Control Relay Output Block: “Count” must be equal to 1 “On Time” and “Off Time” are not handled

8. Object addressing

In the following tables will be found the default settings for the object addresses. The addresses defined here are compatible with the information object addresses of the series 2 T200s.

In these tables do not appear objects which may have been acquired by the T200 (in MODBUS protocol) on the optional link to accessory equipment. This is because their configuration is completely free in relation to the DNP3 protocol (type, information object address), and the only rule to be obeyed is, of course, not to use for one object an address used for another object.

8.1 Legend

Type – Internal No.	Meaning
TCD	Télécommande double (double telecontrol)
TSS	Télésignalisation simple (single telesignal)
TSD	Télésignalisation double (double telesignal)
TM	Télémesure (remote measurement)
CT	Counter

Access	Defined as
VISU	Viewing
EXPL	Operator
ADMIN	Administrator

Options	Required commercial option
I	I, IU, IUP, I2UP TR
U	IU, IUP, I2UP TR
P	IUP, I2UP TR
2U	I2UP TR

Object	Meaning
	In this column appears the type of (static) object used in transmission

Index	Meaning
NA	Not Accessible by SCADA: no index has been configured. For the SCADA to be able to access the Object, simply configure an index (which is not already used)

8.2 T200 P

	Type Internal No.	Access	Options	Object	Index (Dec)	Index (Hex)
Channel 1						
Switch position	TSD 1	VISU		Binary Input	32	20
Switch locked	TSS 49	VISU		Binary Input	68	44
Switch command	TCD 1	EXPL		Control Relay Output Block	4	04
Operation counter	CT 1	VISU		16-Bit Analog Input	NA	NA
Operation counter preset command	TCD 25	ADMIN		Control Relay Output Block	NA	NA
Auxiliary DI	TSS 51	VISU		Binary Input	NA	NA
MV voltage present	TSS 73	VISU		Binary Input	NA	NA
Earth fault	TSS 71	VISU		Binary Input	61	3D
Phase fault	TSS 77	VISU		Binary Input	60	3C
Phase current 1	TM 2	VISU	I	16-Bit Analog Input	NA	NA
Phase current 2	TM 3	VISU	I	16-Bit Analog Input	NA	NA
Phase current 3	TM 4	VISU	I	16-Bit Analog Input	NA	NA
Neutral current	TM 5	VISU	I	16-Bit Analog Input	NA	NA
Average current	TM 6	VISU	I	16-Bit Analog Input	192	C0
U21 voltage measurement	TM 47	VISU	U	16-Bit Analog Input	193	C1
V1 voltage measurement	TM 50	VISU	U	16-Bit Analog Input	NA	NA
Frequency	TM 8	VISU	P	16-Bit Analog Input	NA	NA
Active power	TM 53	VISU	P	16-Bit Analog Input	NA	NA
Reactive power	TM 54	VISU	P	16-Bit Analog Input	NA	NA
Apparent power	TM 55	VISU	P	16-Bit Analog Input	NA	NA
Power factor	TM 7	VISU	P	16-Bit Analog Input	NA	NA
Active energy	CT 5	VISU	P	16-Bit Analog Input	NA	NA
Active energy preset command	TCD 29	ADMIN		Control Relay Output Block	NA	NA
Reactive energy	CT 13	VISU	P	16-Bit Analog Input	NA	NA
Reactive energy preset command	TCD 37	ADMIN		Control Relay Output Block	NA	NA

	Type Internal No.	Access	Options	Object	Index (Dec)	Index (Hex)
Channel 2						
Switch position	TSD 2	VISU		Binary Input	33	21
Switch locked	TSS 81	VISU		Binary Input	69	45
Switch command	TCD 2	EXPL		Control Relay Output Block	5	05
Operation counter	CT 2	VISU		16-Bit Analog Input	NA	NA
Operation counter preset command	TCD 26	ADMIN		Control Relay Output Block	NA	NA
Auxiliary DI	TSS 83	VISU		Binary Input	NA	NA
MV voltage present	TSS 105	VISU		Binary Input	79	4F
Earth fault	TSS 103	VISU		Binary Input	62	3E
Phase fault	TSS 109	VISU		Binary Input	63	3F
Phase current 1	TM 9	VISU	I	16-Bit Analog Input	NA	NA
Phase current 2	TM 10	VISU	I	16-Bit Analog Input	NA	NA
Phase current 3	TM 11	VISU	I	16-Bit Analog Input	NA	NA
Neutral current	TM 12	VISU	I	16-Bit Analog Input	NA	NA
Average current	TM 13	VISU	I	16-Bit Analog Input	194	C2
U21 voltage measurement	TM 56	VISU	U	16-Bit Analog Input	195	C3
V1 voltage measurement	TM 59	VISU	U	16-Bit Analog Input	NA	NA
Frequency	TM 15	VISU	P	16-Bit Analog Input	NA	NA
Active power	TM 62	VISU	P	16-Bit Analog Input	NA	NA
Reactive power	TM 63	VISU	P	16-Bit Analog Input	NA	NA
Apparent power	TM 64	VISU	P	16-Bit Analog Input	NA	NA
Power factor	TM 14	VISU	P	16-Bit Analog Input	NA	NA
Active energy	CT 6	VISU	P	16-Bit Analog Input	NA	NA
Active energy preset command	TCD 30	ADMIN		Control Relay Output Block	NA	NA
Reactive energy	CT 14	VISU	P	16-Bit Analog Input	NA	NA
Reactive energy preset command	TCD 38	ADMIN		Control Relay Output Block	NA	NA
Common objects						
Local/Remote position	TSS 23	VISU		Binary Input	82	52
Door opening	TSS 24	VISU		Binary Input	NA	NA
Fault detection reset command	TCD 17	EXPL		Control Relay Output Block	21	15
Immediate AC power supply defect	TSS 17	VISU		Binary Input	83	53
Time-delayed AC power supply defect	TSS 18	VISU		Binary Input	88	58
Power cut imminent	TSS 25	VISU		Binary Input	NA	NA

	Type Internal No.	Access	Options	Object	Index (Dec)	Index (Hex)
Automatic controls						
Automatic control ON/OFF position	TSD 9	VISU		Binary Input	35	23
Automatic control ON/OFF command	TCD 9	EXPL		Control Relay Output Block	7	07
Automatic control has operated	TSS 57	VISU		Binary Input	89	59
Internal faults						
Motorization power supply failure	TSS 19	VISU		Binary Input	87	57
Accessory equipment power supply failure	TSS 20	VISU		Binary Input	NA	NA
Charger fault	TSS 21	VISU		Binary Input	85	55
Battery fault	TSS 22	VISU		Binary Input	86	56
Digital Inputs/Outputs						
Digital input 1	TSS 1	VISU		Binary Input	76	4C
Digital input 2	TSS 2	VISU		Binary Input	77	4D
Digital input 3	TSS 3	VISU		Binary Input	78	4E
Digital input 4	TSS 4	VISU		Binary Input	NA	NA
Digital input 5	TSS 5	VISU		Binary Input	NA	NA
Digital input 6	TSS 6	VISU		Binary Input	NA	NA
Digital input 7	TSS 7	VISU		Binary Input	NA	NA
Digital input 8	TSS 8	VISU		Binary Input	NA	NA
Digital output 1 position	TSD 5	VISU		Binary Input	NA	NA
Digital output 1 command	TCD 5	EXPL		Control Relay Output Block	NA	NA
Digital output 2 position	TSD 6	VISU		Binary Input	NA	NA
Digital output 2 command	TCD 6	EXPL		Control Relay Output Block	NA	NA
Digital output 3 position	TSD 7	VISU		Binary Input	NA	NA
Digital output 3 command	TCD 7	EXPL		Control Relay Output Block	NA	NA

8.3 T200 I

	Type Internal No.	Access	Options	Object	Index (Dec)	Index (Hex)
Channel 1						
Switch position	TSD 1	VISU		Binary Input	32	20
Switch locked	TSS 49	VISU		Binary Input	68	44
Switch command	TCD 1	EXPL		Control Relay Output Block	4	04
MV voltage present (auxiliary DI)	TSS 54	VISU		Binary Input	78	4E
Earth fault	TSS 71	VISU		Binary Input	61	3D
Phase fault	TSS 77	VISU		Binary Input	60	3C
Phase current	TM 2	VISU		16-Bit Analog Input	192	C0
Channel 2						
Switch position	TSD 2	VISU		Binary Input	33	21
Switch locked	TSS 81	VISU		Binary Input	69	45
Switch command	TCD 2	EXPL		Control Relay Output Block	5	05
MV voltage present (auxiliary DI)	TSS 86	VISU		Binary Input	79	4F
Earth fault	TSS 103	VISU		Binary Input	63	3F
Phase fault	TSS 109	VISU		Binary Input	62	3E
Phase current	TM 9	VISU		16-Bit Analog Input	193	C1
Channel 3						
Switch position	TSD 3	VISU		Binary Input	34	22
Switch locked	TSS 113	VISU		Binary Input	70	46
Switch command	TCD 3	EXPL		Control Relay Output Block	6	06
MV voltage present (auxiliary DI)	TSS 118	VISU		Binary Input	80	50
Earth fault	TSS 135	VISU		Binary Input	65	41
Phase fault	TSS 141	VISU		Binary Input	64	40
Phase current	TM 17	VISU		16-Bit Analog Input	194	C2
Channel 4						
Switch position	TSD 4	VISU		Binary Input	35	23
Switch locked	TSS 145	VISU		Binary Input	71	47
Switch command	TCD 4	EXPL		Control Relay Output Block	7	07
MV voltage present (auxiliary DI)	TSS 150	VISU		Binary Input	81	51
Earth fault	TSS 167	VISU		Binary Input	67	43
Phase fault	TSS 173	VISU		Binary Input	66	42
Phase current	TM 24	VISU		16-Bit Analog Input	195	C3

	Type Internal No.	Access	Options	Object	Index (Dec)	Index (Hex)
Channel 5						
Switch position	TSD 41	VISU		Binary Input	36	24
Switch locked	TSS 321	VISU		Binary Input	100	64
Switch command	TCD 41	EXPL		Control Relay Output Block	8	08
MV voltage present (auxiliary DI)	TSS 326	VISU		Binary Input	110	6E
Earth fault	TSS 343	VISU		Binary Input	93	5D
Phase fault	TSS 349	VISU		Binary Input	92	5C
Phase current	TM 84	VISU		16-Bit Analog Input	196	C4
Channel 6						
Switch position	TSD 42	VISU		Binary Input	37	25
Switch locked	TSS 353	VISU		Binary Input	101	65
Switch command	TCD 42	EXPL		Control Relay Output Block	9	09
MV voltage present (auxiliary DI)	TSS 358	VISU		Binary Input	111	6F
Earth fault	TSS 375	VISU		Binary Input	95	5F
Phase fault	TSS 381	VISU		Binary Input	94	5E
Phase current	TM 91	VISU		16-Bit Analog Input	197	C5
Channel 7						
Switch position	TSD 43	VISU		Binary Input	38	26
Switch locked	TSS 385	VISU		Binary Input	102	66
Switch command	TCD 43	EXPL		Control Relay Output Block	10	0A
MV voltage present (auxiliary DI)	TSS 390	VISU		Binary Input	112	70
Earth fault	TSS 407	VISU		Binary Input	97	61
Phase fault	TSS 413	VISU		Binary Input	96	60
Phase current	TM 99	VISU		16-Bit Analog Input	198	C6
Channel 8						
Switch position	TSD 44	VISU		Binary Input	39	27
Switch locked	TSS 417	VISU		Binary Input	103	67
Switch command	TCD 44	EXPL		Control Relay Output Block	11	0B
MV voltage present (auxiliary DI)	TSS 422	VISU		Binary Input	113	71
Earth fault	TSS 439	VISU		Binary Input	99	63
Phase fault	TSS 445	VISU		Binary Input	98	62
Phase current	TM 106	VISU		16-Bit Analog Input	199	C7

	Type Internal No.	Access	Options	Object	Index (Dec)	Index (Hex)
Channel 9						
Switch position	TSD 81	VISU		Binary Input	40	28
Switch locked	TSS 593	VISU		Binary Input	132	84
Switch command	TCD 81	EXPL		Control Relay Output Block	12	0C
MV voltage present (auxiliary DI)	TSS 598	VISU		Binary Input	142	8E
Earth fault	TSS 615	VISU		Binary Input	125	7D
Phase fault	TSS 621	VISU		Binary Input	124	7C
Phase current	TM 166	VISU		16-Bit Analog Input	200	C8
Channel 10						
Switch position	TSD 82	VISU		Binary Input	41	29
Switch locked	TSS	VISU		Binary Input	133	85
Switch command	TCD 82	EXPL		Control Relay Output Block	13	0D
MV voltage present (auxiliary DI)	TSS	VISU		Binary Input	143	8F
Earth fault	TSS	VISU		Binary Input	127	7F
Phase fault	TSS	VISU		Binary Input	126	7E
Phase current	TM 173	VISU		16-Bit Analog Input	201	C9
Channel 11						
Switch position	TSD 83	VISU		Binary Input	42	2 A
Switch locked	TSS	VISU		Binary Input	134	86
Switch command	TCD 83	EXPL		Control Relay Output Block	14	0E
MV voltage present (auxiliary DI)	TSS	VISU		Binary Input	144	90
Earth fault	TSS	VISU		Binary Input	129	81
Phase fault	TSS	VISU		Binary Input	128	80
Phase current	TM 181	VISU		16-Bit Analog Input	202	CA
Channel 12						
Switch position	TSD 84	VISU		Binary Input	43	2B
Switch locked	TSS	VISU		Binary Input	135	87
Switch command	TCD 84	EXPL		Control Relay Output Block	15	0F
MV voltage present (auxiliary DI)	TSS	VISU		Binary Input	145	91
Earth fault	TSS	VISU		Binary Input	131	83
Phase fault	TSS	VISU		Binary Input	130	82
Phase current	TM 188	VISU		16-Bit Analog Input	203	CB

	Type Internal No.	Access	Options	Object	Index (Dec)	Index (Hex)
Channel 13						
Switch position	TSD 121	VISU		Binary Input	44	2C
Switch locked	TSS 865	VISU		Binary Input	164	A4
Switch command	TCD 121	EXPL		Control Relay Output Block	16	10
MV voltage present (auxiliary DI)	TSS 870	VISU		Binary Input	174	AE
Earth fault	TSS 887	VISU		Binary Input	157	9D
Phase fault	TSS 893	VISU		Binary Input	156	9C
Phase current	TM 248	VISU		16-Bit Analog Input	204	CC
Channel 14						
Switch position	TSD 122	VISU		Binary Input	45	2D
Switch locked	TSS 897	VISU		Binary Input	165	A5
Switch command	TCD 122	EXPL		Control Relay Output Block	17	11
MV voltage present (auxiliary DI)	TSS 902	VISU		Binary Input	175	AF
Earth fault	TSS 919	VISU		Binary Input	159	9F
Phase fault	TSS 925	VISU		Binary Input	158	9^{E}
Phase current	TM 255	VISU		16-Bit Analog Input	205	CD
Channel 15						
Switch position	TSD 123	VISU		Binary Input	46	2E
Switch locked	TSS 929	VISU		Binary Input	166	A6
Switch command	TCD 123	EXPL		Control Relay Output Block	18	12
MV voltage present (auxiliary DI)	TSS 934	VISU		Binary Input	176	B0
Earth fault	TSS 951	VISU		Binary Input	161	A1
Phase fault	TSS 957	VISU		Binary Input	160	A0
Phase current	TM 263	VISU		16-Bit Analog Input	206	CE
Channel 16						
Switch position	TSD 124	VISU		Binary Input	47	2F
Switch locked	TSS 961	VISU		Binary Input	167	A7
Switch command	TCD 124	EXPL		Control Relay Output Block	19	13
MV voltage present (auxiliary DI)	TSS 966	VISU		Binary Input	177	B1
Earth fault	TSS 983	VISU		Binary Input	163	A3
Phase fault	TSS 989	VISU		Binary Input	162	A2
Phase current	TM 270	VISU		16-Bit Analog Input	207	CF
Common objects						
Local/Remote position	TSS 23	VISU		Binary Input	82	52
Fault detection reset command channels 1 to 4	TCD 17	EXPL		Control Relay Output Block	21	15
Fault detection reset command channels 5 to 8	TCD 57	EXPL		Control Relay Output Block	NA	NA
Fault detection reset command channels 9 to 12	TCD 97	EXPL		Control Relay Output Block	NA	NA
Fault detection reset command channels 13 to 16	TCD 137	EXPL		Control Relay Output Block	NA	NA
Immediate AC power supply defect	TSS 17	VISU		Binary Input	83	53
Time-delayed AC power supply defect	TSS 18	VISU		Binary Input	88	58
Power cut imminent	TSS 25	VISU		Binary Input	NA	NA

	Type Internal No.	Access	Options	Object	Index (Dec)	Index (Hex)
Automatic controls						
Automatic control ON/OFF position channels 1 to 4	TSD 9	VISU		Binary Input	52	34
Automatic control ON/OFF command channels 1 to 4	TCD 9	EXPL		Control Relay Output Block	24	18
Automatic control ON/OFF position channels 5 to 8	TSD 49	VISU		Binary Input	53	35
Automatic control ON/OFF command channels 5 to 8	TCD 49	EXPL		Control Relay Output Block	25	19
Automatic control ON/OFF position channels 9 to 12	TSD 89	VISU		Binary Input	54	36
Automatic control ON/OFF command channels 9 to 12	TCD 89	EXPL		Control Relay Output Block	26	1A
Automatic control ON/OFF position channels 13 to 16	TSD 129	VISU		Binary Input	55	37
Automatic control ON/OFF command channels 13 to 16	TCD 129	EXPL		Control Relay Output Block	27	1B
Internal faults						
Motorization power supply failure	TSS 19	VISU		Binary Input	87	57
Accessory equipment power supply failure	TSS 20	VISU		Binary Input	NA	NA
Charger fault	TSS 21	VISU		Binary Input	85	55
Battery fault	TSS 22	VISU		Binary Input	86	56
Fault detector link defect	TSS 47	VISU		Binary Input	NA	NA
Digital inputs						
Digital input 1	TSS 1	VISU		Binary Input	76	4C
Digital input 2	TSS 2	VISU		Binary Input	77	4D
Digital input 3	TSS 3	VISU		Binary Input	84	54
Digital input 4	TSS 4	VISU		Binary Input	89	59
Digital input 5	TSS 5	VISU		Binary Input	90	5 A
Digital input 6	TSS 6	VISU		Binary Input	91	5B
Digital input 7	TSS273	VISU		Binary Input	108	6C
Digital input 8	TSS274	VISU		Binary Input	109	6D
Digital input 9	TSS275	VISU		Binary Input	116	74
Digital input 10	TSS276	VISU		Binary Input	121	79
Digital input 11	TSS277	VISU		Binary Input	122	7 A
Digital input 12	TSS278	VISU		Binary Input	123	7B
Digital input 13	TSS545	VISU		Binary Input	140	8C
Digital input 14	TSS546	VISU		Binary Input	141	8D
Digital input 15	TSS547	VISU		Binary Input	148	94
Digital input 16	TSS548	VISU		Binary Input	153	99
Digital input 17	TSS549	VISU		Binary Input	154	9A
Digital input 18	TSS550	VISU		Binary Input	155	9B
Digital input 19	TSS817	VISU		Binary Input	172	AC
Digital input 20	TSS818	VISU		Binary Input	173	AD
Digital input 21	TSS819	VISU		Binary Input	180	B4
Digital input 22	TSS820	VISU		Binary Input	185	B9
Digital input 23	TSS821	VISU		Binary Input	186	BA
Digital input 24	TSS822	VISU		Binary Input	187	Bb

8.4 Flair 200C

	Type N°interne	Accès	Options	Objet	Index (Dec)	Index (Hex)
Flair 200C state						
Fault current indicator reset	TCD17	EXPL		Control Relay Output Block	4	4
Missing voltage	TSS17	VISU		Binary Input	28	1C
Charger fault	TSS21	VISU		Binary Input	16	10
Battery fault	TSS22	VISU		Binary Input	17	11
General shutdown	TSS25	VISU		Binary Input	-	-
Battery disconnected	TSS26	VISU		Binary Input	18	12
Battery low	TSS27	VISU		Binary Input	-	-
Equipment start	TSS31	VISU		Binary Input	-	-
Test communication	TSS32	VISU		Binary Input	-	-
Measure						
Frequency	TM20	VISU		16-Bit Analog Input	46	2E
Voltage measure	TM42	VISU		16-Bit Analog Input	47	2F
Measure channel 1						
Current P1	TM21	VISU		16-Bit Analog Input	40	28
Current P2	TM26	VISU		16-Bit Analog Input	41	29
Current P3	TM31	VISU		16-Bit Analog Input	42	2A
Io Current	TM36	VISU		16-Bit Analog Input	43	2B
Mean phase current	TM41	VISU		16-Bit Analog Input	44	2C
Power factor	TM47	VISU		16-Bit Analog Input	45	2D
Active power	TM48	VISU		16-Bit Analog Input	48	30
Reactive power	TM52	VISU		16-Bit Analog Input	49	31
Apparent power	TM56	VISU		16-Bit Analog Input	50	32
Active energy	CNT101	VISU		16-Bit Analog Input	60	3C
Reactive energy	CNT103	VISU		16-Bit Analog Input	-	-
Fault channel 1						
Fast earth fault	TSS71	VISU		Binary Input	27	1B
Earth fault	TSS72	VISU		Binary Input	26	1A
Fast phase fault	TSS76	VISU		Binary Input	30	1E
Phase fault	TSS77	VISU		Binary Input	29	1D
Counter fast earth fault	CNT7	VISU		16-Bit Analog Input	-	-
Counter earth fault	CNT8	VISU		16-Bit Analog Input	-	-
Counter fast phase fault	CNT10	VISU		16-Bit Analog Input	-	-
Counter phase fault	CNT11	VISU		16-Bit Analog Input	-	-

Measure channel 2						
Current P1	TM71	VISU		16-Bit Analog Input	51	33
Current P2	TM76	VISU		16-Bit Analog Input	52	34
Current P3	TM81	VISU		16-Bit Analog Input	53	35
Io Current	TM86	VISU		16-Bit Analog Input	54	36
Mean phase current	TM91	VISU		16-Bit Analog Input	55	37
Power factor	TM97	VISU		16-Bit Analog Input	56	38
Active power	TM98	VISU		16-Bit Analog Input	57	39
Reactive power	TM102	VISU		16-Bit Analog Input	58	3A
Apparent power	TM106	VISU		16-Bit Analog Input	59	3B
Active energy	CNT102	VISU		16-Bit Analog Input	61	3D
Reactive energy	CNT104	VISU		16-Bit Analog Input	-	-
Fault channel 2						
Fast earth fault	TSS103	VISU		Binary Input	35	23
Earth fault	TSS104	VISU		Binary Input	34	22
Fast phase fault	TSS108	VISU		Binary Input	38	26
Phase fault	TSS109	VISU		Binary Input	37	25
Counter fast earth fault	CNT12	VISU		16-Bit Analog Input	-	-
Counter earth fault	CNT13	VISU		16-Bit Analog Input	-	-
Counter fast phase fault	CNT15	VISU		16-Bit Analog Input	-	-
Counter phase fault	CNT16	VISU		16-Bit Analog Input	-	-
Temperature measurement						
Internal temperature	TM10	VISU		16-Bit Analog Input	-	-
External temperature estimated	TM11	VISU		16-Bit Analog Input	39	27
Digital inputs						
Digital input 1	TSS1	VISU		Binary Input	10	A
Digital input 2	TSS2	VISU		Binary Input	11	B
Digital input 3	TSS3	VISU		Binary Input	12	C
Digital input 4	TSS4	VISU		Binary Input	13	D
Digital input 5	TSS5	VISU		Binary Input	14	E
Digital input 6	TSS6	VISU		Binary Input	15	F

Digital inputs counters						
Counter digital input 1	CNT1	VISU		16-Bit Analog Input	-	-
Counter digital input 2	CNT2	VISU		16-Bit Analog Input	-	-
Counter digital input 3	CNT3	VISU		16-Bit Analog Input	-	-
Counter digital input 4	CNT4	VISU		16-Bit Analog Input	-	-
Counter digital input 5	CNT5	VISU		16-Bit Analog Input	-	-
Counter digital input 6	CNT6	VISU		16-Bit Analog Input	-	-
Digital outputs						
Digital output 1	TCD1	EXPL		Control Relay Output Block	1	1
Digital output 2	TCD2	EXPL		Control Relay Output Block	2	2
Digital output 3	TCD3	EXPL		Control Relay Output Block	3	3
Digital output 1	TSD1	VISU		Binary Input	31	1F
Digital output 2	TSD2	VISU		Binary Input	32	20
Digital output 3	TSD3	VISU		Binary Input	33	21
Double digital outputs						
Digital output 1-2	TCD4	EXPL		Control Relay Output Block	-	-
Digital input 1-2	TSD4	VISU		Binary Input	-	-

8.5 T200 S

	Type Internal No.	Access	Options	Object	Index (Dec)	Index (Hex)
Channel 1						
Switch position	TSD 1	VISU		Binary Input	32	20
Switch locked	TSS 49	VISU		Binary Input	68	44
Switch command	TCD 1	EXPL		Control Relay Output Block	4	04
Operation counter	CNT 1	VISU		16-Bit Analog Input	NA	NA
Operation counter preset command	TCD 25	ADMIN		Control Relay Output Block	NA	NA
Auxiliary DI	TSS 51	VISU		Binary Input	NA	NA
MV voltage present	TSS 73	VISU		Binary Input	80	50
Aux. MV voltage present	TSS 54	VISU		Binary Input	NA	NA
Earth fault	TSS 71	VISU		Binary Input	61	3D
Phase fault	TSS 77	VISU		Binary Input	60	3C
Phase current 1	TM 2	VISU		16-Bit Analog Input	NA	NA
Phase current 2	TM 3	VISU		16-Bit Analog Input	NA	NA
Phase current 3	TM 4	VISU		16-Bit Analog Input	NA	NA
Neutral current	TM 5	VISU		16-Bit Analog Input	NA	NA
Average current	TM 6	VISU		16-Bit Analog Input	192	C0

	Type Internal No.	Access	Options	Object	Index (Dec)	Index (Hex)
Channel 2						
Switch position	TSD 2	VISU		Binary Input	33	21
Switch locked	TSS 81	VISU		Binary Input	69	45
Switch command	TCD 2	EXPL		Control Relay Output Block	5	05
Operation counter	CNT 2	VISU		16-Bit Analog Input	NA	NA
Operation counter preset command	TCD 26	ADMIN		Control Relay Output Block	NA	NA
Auxiliary DI	TSS 83	VISU		Binary Input	NA	NA
MV voltage present	TSS 105	VISU		Binary Input	79	4F
Aux. MV voltage present	TSS 86	VISU		Binary Input	NA	NA
Earth fault	TSS 103	VISU		Binary Input	62	3E
Phase fault	TSS 109	VISU		Binary Input	63	3F
Phase current 1	TM 9	VISU		16-Bit Analog Input	NA	NA
Phase current 2	TM 10	VISU		16-Bit Analog Input	NA	NA
Phase current 3	TM 11	VISU		16-Bit Analog Input	NA	NA
Neutral current	TM 12	VISU		16-Bit Analog Input	NA	NA
Average current	TM 13	VISU		16-Bit Analog Input	193	C1
Common objects						
Local/Remote position	TSS 23	VISU		Binary Input	82	52
Door opening	TSS 24	VISU		Binary Input	78	4E
Fault detection reset command	TCD 17	EXPL		Control Relay Output Block	21	15
Immediate AC power supply defect	TSS 17	VISU		Binary Input	83	53
Time-delayed AC power supply defect	TSS 18	VISU		Binary Input	88	58
Power cut imminent	TSS 25	VISU		Binary Input	NA	NA
SNTP synchronised	TSL 79	VISU		Binary Input	NA	NA

	Type Internal No.	Access	Options	Object	Index (Dec)	Index (Hex)
Automatic controls						
Automatic control ON/OFF position	TSD 9	VISU		Binary Input	35	23
Automatic control ON/OFF command	TCD 9	EXPL		Control Relay Output Block	7	07
Automatic control has operated	TSS 57	VISU		Binary Input	89	59
Internal faults						
Motorization power supply failure	TSS 19	VISU		Binary Input	87	57
Accessory equipment power supply failure	TSS 20	VISU		Binary Input	NA	NA
Charger fault	TSS 21	VISU		Binary Input	85	55
Battery fault	TSS 22	VISU		Binary Input	86	56
Equipment fault	TSS 29	VISU		Binary Input	NA	NA
Digital Inputs/Outputs						
Digital input 1	TSS 1	VISU		Binary Input	76	4C
Digital input 2	TSS 2	VISU		Binary Input	77	4D
Digital input 3	TSS 3	VISU		Binary Input	NA	NA
Digital input 4	TSS 4	VISU		Binary Input	NA	NA
Digital input 5	TSS 5	VISU		Binary Input	NA	NA
Digital input 6	TSS 6	VISU		Binary Input	NA	NA
Digital input 7	TSS 7	VISU		Binary Input	NA	NA
Digital input 8	TSS 8	VISU		Binary Input	NA	NA
Digital output 2 position	TSD 6	VISU		Binary Input	NA	NA
Digital output 2 command	TCD 6	EXPL		Control Relay Output Block	NA	NA
Digital output 3 position	TSD 7	VISU		Binary Input	NA	NA
Digital output 3 command	TCD 7	EXPL		Control Relay Output Block	NA	NA

8.6 R200-ATS100

Object type cross-reference table:

Object type	T200/F200C	Designation	Comment
SPS	TSS,DI	Single Point Status	
DPS	TSD, DDI	Double Point Status	
SPC	TCS, DO	Single Point Control	Possibly associated to an SPS
DPC	TCD, DDO	Double Point Control	Possibly associated to a DPS
MV	TM,AI	Measured Value	On 16 and 32 bits
APC	AO	Analogue Point Control	On 16 and 32 bits
INC	CNT	Integer Control	On 16 and 32 bits (used for presettable counters)

Access

A = Administrator (ADMIN), O = Operator (EXPL), M= Monitoring (VISU)

8.6.1 RTU data

	Source	Access	Object	Index (Dec)	Index (Hex)
RTU Specific Data					
Equipment start	R200, ATS100	A	SPS	n/a	n/a
Automatism Data					
Automatism	ATS100	O	DPC	7212	1C2Ch
Go to parallel	ATS100 (ACO/BTA)	O	DPC	7216	1C30h
Go to S1	ATS100	O	DPC	7218	1C32h
Go to Off	ATS100	O	DPC	7220	1C34h
Go to S2	ATS100	O	DPC	7222	1C36h
Go to S1 & S2	ATS100 (BTA)	O	DPC	7224	1C38h
Automatism state	ATS100	D	DPS	9292	244Ch
Automatism has started	ATS100	D	SPS	8015	1F4Fh
Automatism locked	ATS100	D	SPS	8016	1F50h
RTU Digital I/O data					
Digital output 1	R200	O	DPC	7200	1C20h
Digital output 2	R200	O	DPC	7202	1C22h
Digital output 3	R200	O	DPC	7204	1C24h
Digital output 4	R200	O	DPC	7206	1C26h
Double digital output 1-2	R200	O	DPC	7208	1C28h
Double digital output 3-4	R200	O	DPC	7210	1C2Ah
Digital output 1	ATS100 (ACO/BTA)	O	DPC	7200	1C20h
Digital output 2	ATS100 (ACO/BTA)	O	DPC	7202	1C22h
Digital output 1	R200	D	DPS	9280	2440h
Digital output 2	R200	D	DPS	9282	2442h
Digital output 3	R200	D	DPS	9284	2444h
Digital output 4	R200	D	DPS	9286	2448h
Double digital output 1-2	R200	D	DPS	9288	244Ah
Double digital output 3-4	R200	D	DPS	9290	244Ch
Double digital input 1-2	R200	D	DPS	-	
Double digital input 3-4	R200	D	DPS	-	

RTU Digital I/O data					
Digital output 1	ATS100 (ACO/BTA)	D	DPS	9280	2440h
Digital output 2	ATS100 (ACO/BTA)	D	DPS	9282	2442h
Source transfer in progress	ATS100 (ACO/BTA)	D	DPS	9284	2444h
S1 or S2 available	ATS100 (ACO/BTA)	D	DPS	9286	2448h
Digital input 1	R200	D	SPS	8001	1F41h
Digital input 2	R200	D	SPS	8002	1F42h
Digital input 3	R200	D	SPS	8003	1F43h
Digital input 4	R200	D	SPS	8004	1F44h
Digital input 5	R200	D	SPS	8005	1F45h
Digital input 6	R200	D	SPS	8006	1F46h
Digital input 7	R200	D	SPS	8007	1F47h
Digital input 8	R200	D	SPS	8008	1F48h
Digital input 1	ATS100 (ACO/BTA)	D	SPS	8001	1F41h
Digital input 2	ATS100 (ACO/BTA)	D	SPS	8002	1F42h
Digital input 3	ATS100 (ACO/BTA)	D	SPS	8003	1F43h
Digital input 4	ATS100 (ACO/BTA)	D	SPS	8004	1F44h
Voltage presence S1	ATS100 (ACO/BTA)	D	SPS	8005	1F45h
Voltage presence S2	ATS100 (ACO/BTA)	D	SPS	8006	1F46h
Transfer locking	ATS100 (ACO/BTA)	D	SPS	8007	1F47h
Parallel transfer enable	ATS100 (ACO/BTA)	D	SPS	8008	1F48h
RTU Measurement data					
Internal temperature	R200, ATS100	D	MV16	800	320
Substation global data					
Local/Remote	R200, ATS100	D	SPS	8000	1F40h
System minor fault	R200, ATS100	D	SPS	8009	1F49h
System major fault	R200, ATS100	D	SPS	8010	1F4Ah
Maintainance mode	R200, ATS100	D	SPS	8011	1F4Bh
Test SCADA com	R200, ATS100	A	SPS	8012	1F4Ch
System event loss	R200, ATS100	A	SPS	8017	1F51h

8.6.2 Global data

	Source	Access	Object	Index (Dec)	Index (Hex)
Global data					
Restart 24/48V	PS100	O	SPC	n/a	n/a
AC OFF	PS100	D	SPS	8025	1F59h
General Shutdown	PS100	D	SPS	8026	1F5Ah
Battery Low	PS100	D	SPS	8027	1F5Bh
Battery Fault	PS100	D	SPS	8028	1F5Ch
Charger Fault	PS100	D	SPS	8029	1F5Dh
12V failure	PS100	D	SPS	8030	1F5Eh
24/48V failure	PS100	D	SPS	8031	1F5Fh
Battery Charge Indicator	PS100	O	MV16	n/a	n/a

8.6.3 Cubicle 1 data

	Source	Access	Object	Index (Dec)	Index (Hex)
Cubicle 1 data					
Switchgear position	SC110	O	DPC	7232	1C40h
Simulated position	SC110	A	DPC	7234	1C42h
Spring charge locking	SC110	A	DPC	n/a	n/a
Protection setting group	VIP410	O	DPC	7236	1C44h
Switchgear position	SC110	D	DPS	9312	2460h
Earth switch position	SC110	D	DPS	9314	2462h
Simulated position	SC110	A	DPS	9316	2464h
Spring charge locking	SC110	A	DPS	n/a	n/a
Active setting group	VIP410	D	DPS	9318	2466h
Current Maximeters	Flair23DM	O	SPC	n/a	n/a
Fault passage indication	Flair23DM	O	SPC	6416	1910h
Trip indication	VIP410	O	SPC	6417	1911h
Phase peak demand values	VIP410	O	SPC	n/a	n/a
Switchgear control failure	SC110	O	SPS	n/a	n/a
Trip indication	SC110	D	SPS	8048	1F70h
Ready to operate	SC110	A	SPS	n/a	n/a
Ready for remote command	SC110	O	SPS	n/a	n/a
Local/Remote switch state	SC110	D	SPS	n/a	n/a
Phase fault	Flair23DM	D	SPS	8049	1F71h
Earth fault	Flair23DM	D	SPS	8050	1F72h
Transient phase fault	Flair23DM	D	SPS	n/a	n/a
Transient earth fault	Flair23DM	D	SPS	n/a	n/a
Fault by test action	Flair23DM	D	SPS	8051	1F73h
Phase or earth fault	Flair23DM	D	SPS	n/a	n/a
MV voltage presence	Flair23DM	D	SPS	8052	1F74h
MV voltage presence (V1 or U12)	Flair23DM	A	SPS	8053	1F75h
MV voltage presence (V2 or U13)	Flair23DM	A	SPS	8054	1F76h
MV voltage presence (V3 or U23)	Flair23DM	A	SPS	8055	1F77h
Residual voltage presence	Flair23DM	D	SPS	8056	1F78h
MV voltage absence	Flair23DM	D	SPS	8057	1F79h
MV voltage absence (V1 or U12)	Flair23DM	A	SPS	8058	1F7Ah
MV voltage absence (V2 or U13)	Flair23DM	A	SPS	8059	1F7Bh
MV voltage absence (V3 or U23)	Flair23DM	A	SPS	8060	1F7Ch
Max Current Reset Indication	Flair23DM	O	SPS	n/a	n/a
Protection 50-51 I>, delayed	VIP410	O	SPS	n/a	n/a
Protection 50-51 I>>, delayed	VIP410	O	SPS	n/a	n/a
Protection 50-51 I>>>, delayed	VIP410	O	SPS	n/a	n/a
Protection 50-51 I>, pick-up	VIP410	O	SPS	n/a	n/a
Protection 50-51 I>>, pick-up	VIP410	O	SPS	n/a	n/a
Protection 50-51 I>>>, pick-up	VIP410	O	SPS	n/a	n/a
Protection 50N-51N Io>, delayed	VIP410	O	SPS	n/a	n/a
Protection 50N-51N Io>>, delayed	VIP410	O	SPS	n/a	n/a
Protection 50N-51N Io>, pick-up	VIP410	O	SPS	n/a	n/a
Protection 50N-51N Io>>, pick-up	VIP410	O	SPS	n/a	n/a
Protection 49 RMS thermal alarm	VIP410	O	SPS	n/a	n/a

Cubicle 1 data					
Protection 49 RMS thermal tripping	VIP410	O	SPS	n/a	n/a
External trip by external input	VIP410	O	SPS	8061	1F7Dh
Tripping	VIP410	D	SPS	8062	1F7Eh
Trip by test menu	VIP410	O	SPS	8063	1F7Fh
Trip Indication	VIP410	D	SPS	8064	1F80h
Phase peak demand values reset indication	VIP410	A	SPS	n/a	n/a
Operation counter	SC110	O	INC32	n/a	n/a
Trip counter	SC110	D	INC32	n/a	n/a
Phase + earth fault counter	Flair23DM	D	INC32	n/a	n/a
Phase fault counter	Flair23DM	D	INC32	n/a	n/a
Earth fault counter	Flair23DM	D	INC32	n/a	n/a
Number of trip : phase fault	VIP410	D	INC32	n/a	n/a
Number of trip : earth fault	VIP410	D	INC32	n/a	n/a
Number of trip : thermal overload	VIP410	D	INC32	n/a	n/a
Number of trip : external trip	VIP410	D	INC32	n/a	n/a
Energy, active total MSB	PM800	D	INC32	10840	2A58h
Energy, active total LSB	PM800	D	INC32	10842	2A5Ah
Energy, reactive total MSB	PM800	D	INC32	10844	2A5Ch
Energy, reactive total LSB	PM800	D	INC32	10846	2A5Eh
Energy, apparent MSB	PM800	A	INC32	10848	2A60h
Energy, apparent MSB	PM800	A	INC32	10850	2A62h
Phase current I1	Flair23DM	D	MV16	860	035Ch
Phase current I2	Flair23DM	D	MV16	861	035Dh
Phase current I3	Flair23DM	D	MV16	862	035Eh
Residual current I0	Flair23DM	D	MV16	863	035Fh
I1 max	Flair23DM	O	MV16	n/a	n/a
I2 max	Flair23DM	O	MV16	n/a	n/a
I3 max	Flair23DM	O	MV16	n/a	n/a
Phase current I1	VIP410	D	MV16	864	0360h
Phase current I2	VIP410	D	MV16	865	0361h
Phase current I3	VIP410	D	MV16	866	0362h
Measured Earth Fault Current I0	VIP410	D	MV16	867	0363h
Phase peak demand current Im1 (mean current)	VIP410	O	MV16	n/a	n/a
Phase peak demand current Im2 (mean current)	VIP410	O	MV16	n/a	n/a
Phase peak demand current Im3 (mean current)	VIP410	O	MV16	n/a	n/a
Phase current I1	PM800	D	MV16	868	0364h
Phase current I2	PM800	D	MV16	869	0365h
Phase current I3	PM800	D	MV16	870	0366h
Residual current I0	PM800	D	MV16	871	0367h
Voltage U12	PM800	A	MV16	872	0368h
Voltage U23	PM800	A	MV16	873	0369h
Voltage U31	PM800	A	MV16	874	036Ah
Mean voltage between phases	PM800	A	MV16	875	036Bh
Voltage V1	PM800	A	MV16	876	036Ch
Voltage V2	PM800	A	MV16	877	036Dh
Voltage V3	PM800	A	MV16	878	036Eh
Voltage NR	PM800	A	MV16	879	036Fh
Mean voltage phase-N	PM800	A	MV16	880	0370h
Frequency	PM800	A	MV16	881	0371h

Cubicle 1 data					
Real power, total	PM800	A	MV16	882	0372h
Reactive power, total	PM800	A	MV16	883	0373h
Apparent power, total	PM800	A	MV16	884	0374h
True power factor, total	PM800	A	MV16	885	0375h

8.6.4 Cubicle xxx data

Same principles apply for further cubicles, with same default variables and default external address. From the tables of previous paragraph, just add an offset for default external address as follows:

Object type	Index Decimal Offset per cubicle	Index dec depending on cubicle number
		Base + Dec Offset*(Cub_Nb-1)
DPC	16	Base + 16*(Cub_Nb-1)
DPS	16	Base + 16*(Cub_Nb-1)
SPC	16	Base + 16*(Cub_Nb-1)
SPS	32	Base + 32*(Cub_Nb-1)
INC32	120	Base + 120*(Cub_Nb-1)
Energies	40	Base + 40*(Cub_Nb-1)
MV16	60	Base + 60*(Cub_Nb-1)
MV32	120	Base + 120*(Cub_Nb-1)

Where “Base” is the default decimal index of corresponding object in Cubicle1.

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